NAVAL POSTGRADUATE SCHOOL

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THESIS

IMPROVING GOVERNMENT'S RETIREMENT PLAN INVESTMENTS BY USING MINING TOOLS FOR DISCOVERY OF PRICE PATTERNS AND COMBINING METHODS OF FUNDAMENTAL AND TECHNICAL ANALYSIS

by

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June 2008

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There are many tools available to government fund managers for making investment decisions, especially regarding the retirement options available to US service members, including Social Security, Military Retirement, Traditional Individual Retirement Accounts, Roth Individual Retirement Accounts and Uniformed Services Thrift Savings Plan.

This project concentrates on both long and short term investments by exploiting the combination of two types of investment methods. The first is to predict the future directions of prices by discovering the patterns of prices. The other is to combine fundamental and technical analysis successfully, which requires the study of their relationship.

The project consists of two independent parts. The first part introduces a knowledge representation model that codifies stock price movements in binary format and then applies proper data mining techniques in order to discover profitable patterns of four candlesticks. The second part seeks to answer the question: "If there are relationships between technical and fundamental analysis, can strategies to increase investment returns be developed?

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EXECUTIVE SUMMARY

Strategies developed in this project can help Governmental fund managers increase the return of investments in the New York Stock Exchange. These strategies can be used by governmental agents who deal with retirement plans such as Social Security, Military Retirement, Traditional Individual Retirement Accounts, Roth Individual Retirement Accounts and Uniformed Services Thrift Savings Plan. The results of this research can also be used by individuals to make their own investments in the stock market.

Although there are many different categories of investments (stocks, bonds, futures, etc), the research here is concentrated on stock trading in the New York Stock Exchange.

The project deals with the two independent types of research, which can be combined to make better trade decisions. The first part of the research revealed hidden price patterns beyond the popular candlesticks that can help predict the future price trend (up or down) of stock prices, sometimes ten days in advance. However, these patterns rarely appear, but they are still helpful. The second part of the research discovered useful relationships between fundamental and technical analysis which can improve the investments of retirement plans.

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I. INTRODUCTION

A. PURPOSE

The purpose of this project is to develop new approaches and methods to maximize investments. Moreover, it is expected this project will help Government fund managers, especially those who deal with retirement plans, increase the returns of their investments in any type of instruments such as bonds and stocks.

Although there are many different categories of investments (stocks, bonds, futures, etc), the research here is concentrated on stock trading in the New York Stock Exchange. Additionally, the results of this research can be used by individual military personnel and government employees to make their own investments in the stock market.

B. RETIREMENT PLANS

1. Types of Retirement Plans

There are various retirement plans [1]such as government sponsored plans, personal plans, annuities and employer sponsored plans. The largest government sponsored retirement plan is Social Security. Personal plans are optional; individuals can select their own retirement plan, such as an Individual Retirement Account.

Annuities are contracts established with an insurance company. Employer sponsored plans can be qualified or non-qualified. Qualified plans meet the Internal Revenue Code (IRC) and the Employee Retirement Income Security Act of 1974 (ERISA). Examples of qualified plans are the defined benefit plans which are company retirement plans such as pension plans. Pension plans depend on salary history and years of service. Non qualified retirement plans do not meet the requirements of IRC or

1 Investor Guide Staff, "Types of Retirement Plans", April 2008, http://www.investorguide.com/igu-article-748-retirement-planning-types-of-retirement-plans.html.

ERICA; they are more flexible and are funded by employees. Some of the important retirement plans are explained in more detail below.

a. Social Security

The Social Security program[2] was established during the Great Depression of the 1930s when poverty rates among citizens exceeded 50%. It was originally designed to protect average citizens from poverty, old age, disabilities, etc. Generally, it provides insurance benefits for Americans when they retire, and Medicare and disability insurance, benefits, and supplemental security income for people who are 65 or older, blind or otherwise disabled[3]. Currently, this program is funded by payroll taxes through the Federal Insurance Contributions Act (FICA).

b. Military Retirement

The military retirement [4]system provides retirement benefits after an active or reserve military career. Disability and survivor benefits are also provided for eligible relatives of survivors and deceased retirees.

c. Individual Retirement Account (IRA)

Individual Retirement Accounts[5] are provided for people under the age of 70.5. The amount allowed for investment depends on the type of IRA under the tax law. There are five different types of IRAs: traditional, Education, Roth, Simple, and SEP (Simplified Employee Pension). After 2008, there is an annual limit of $5,000 for

2 Wikipedia encyclopedia, April 2008, http://en.wikipedia.org/wiki/Social_Security_(United_States).

3 The official Website of the U.S. Social Security Administration, April 2008, line:http://www.ssa.gov/r&m6.htm.

4 Federal of American Scientists Website, April 2008, http://www.fas.org/sgp/crs/natsec/IB85159.pdf.

5 The internet Retirement Alliance Website, April 2008, http://www.ira.com/faq/faq-01.htm.

traditional and Roth IRAs[6], which may be adjusted annually for inflation. Although there is a limitation, individuals can have IRA accounts at different institutions such as banks, brokers, etc.

Institutions that administrate IRA accounts can invest in a variety of different instruments such as bonds, mutual funds, stocks, future and options. It should be noted that individuals are allowed [7]to control assets from a 401(k), 457 and 403(b) and make their own choices regarding current taxes and penalties.

d. Thrift Savings Plan (TSP)

The Thrift Savings Plan provides retirement income to civilians who were past employees of the United States Government or uniformed services. It has been available to civilian employees of the Federal Government since 1987; the provision for participants of the uniformed services was activated by the Floyd D. Spence National Defense Authorization Act of Fiscal Year 2001 which was signed by President Clinton, October 30, 2008.

Participants of the TSP must sign up to become members and determine the funds in which they participate. Participants pay through a special account administered by the Federal Retirement Thrift Investment Board. Members can invest any portion of their account in six different funds:

- Government Securities Investment (G) Fund
- Fixed Income Index Investment (F) Fund
- Common Stock Index Investment (C) Fund
- Small Capitalization Stock Index Investment (S) Fund
- International Stock Index Investment (I) Fund

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6 The internet Retirement Alliance Website, April 2008, http://www.ira.com/faq/faq-05.htm..

7 E*Trade Website, “Rollover IRA”, April 2008, https://us.etrade.com/e/t/welcome/iraroll.

8 Air Reserve Personnel Center Website, April 2008, http://www.arpc.afrc.af.mil/shared/media/document/AFD-070523-014.pdf.

- Lifecycle (L) Funds

The G Fund[9] has no credit risk because, by law, it must be invested in non-marketable U.S. Treasury securities that are specially issued to the TSP. The objective is to maintain a return rate higher than the inflation rate.

The F Fund [10] by law must be invested in fixed-income securities, and especially in an index fund that tracks the Lehman Brothers U.S. Aggregate (LBA) Index, a diversified index of the U.S. bond market. The LBA Index consists of high quality fixed-income securities older than one year. Generally, it has relatively low risk.

The C Fund[11] offers the opportunity for a potentially high investment, but there is a risk of loss (market risk). This is because according to the law, funds must be invested in a portfolio that consists of stocks representing the U.S. Stock Market, especially the stocks which belong to the S&P 500 index. The S&P 500 is an index of 500 large to medium sized U.S. companies that are traded in the Stock Market.

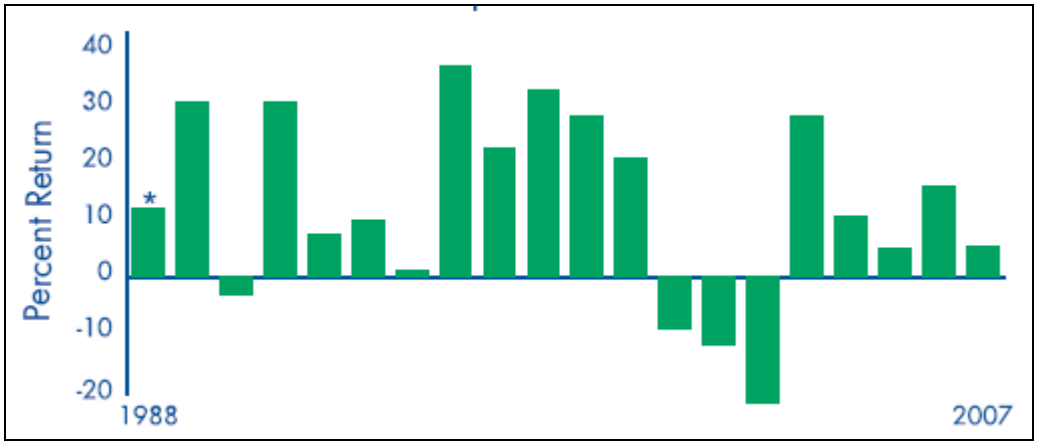

Figure 1. C Fund Returns Inception - 2007

9 Government Securities Investment Fund Website, "Thrift Saving Plan", April 2008, http://www.tsp.gov/rates/fundsheet-gfund.pdf.

10 Government Securities Investment Fund Website, "Thrift Saving Plan", April 2008, http://www.tsp.gov/rates/fundsheet-ffund.pdf.

11 Ibid.

The S Fund[12] is similar to the C Fund, but with its portfolio consists of stocks that represent small companies and belong to the Dow Jones Wilshire 4500 Completion Index (DJW 4500, which consists of all common stocks that are not included in the S&P 500 Index. The possibility of earning better investment rates with the S Fund is higher than with the C Fund, but there is also a higher risk of loss during market recessions.

According to law, the I Fund[13] must be invested in a portfolio that tracks the performances of indexes of common stocks representing stock markets outside of the United States. The I Fund is meant to match the performance of the Morgan Stanley Capital International EAFE (Europe, Australia, Far East) Index. There are two risks involved with this fund: the market risk depending on the current economic condition, as well as currency risk, which refer to the value of the U.S. dollar. The L Fund[14] portfolio consists of several instruments such as domestic stocks, international stocks, and bonds. These lifecycle funds can only be invested in the five funds currently offered by TSP (G, F, C, S and I).

2. Ways to Increase the Return of Investment

Investments can be applied to various assets related to the stock market such as bonds, funds, stocks, commodities, futures, options, foreign exchange (Forex). These assets can be domestically or internationally originated. Some of them are low risk such as bonds, and others are high risk such as futures and options.

Some high risk retirement plans increase the possibility of high returns of investments. These types of retirement plans are implemented by government agents and institutes, or controlled by individuals. This research concentrates on increasing the

12 Government Securities Investment Fund Website, “Thrift Saving Plan”, April 2008, http://www.tsp.gov/rates/fundsheet-ffund.pdf.

13 Government Securities Investment Fund Website, “Thrift Saving Plan”, April 2008, http://www.tsp.gov/rates/fundsheet-ifund.pdf.

14 Government Securities Investment Fund Website, “Thrift Saving Plan”, April 2008, http://www.tsp.gov/lifecycle/flash/qs_as.html.

returns of high or medium risk assets, especially those in U.S. stocks. Only a few retirement plans involve investments in stocks.

The government fund managers of the Thrift Savings Plan can use the results of this research, especially for the funds which involve stocks (Fund C, Fund S). Fund managers from various institutes who control IRA accounts can also these results. Some IRA accounts, such as 401(k), allow individuals to control the selection stocks; this requires knowledge and time on behalf of the individual.

C. RESEARCH QUESTIONS

There are two basic directions of research:

The first category is the study of price patterns. Specifically, there is an attempt to answer the following questions:

- Are there are any new bearish patterns besides the widely known candlesticks? If so, how can they be used as efficiently as possible?
- Are there are any new bullish patterns (besides the widely known candlesticks)? If so, how can they be used as efficiently as possible?
- Can the future direction of stock prices be predicted based on pattern discovery techniques? How far in advance can these predictions be realistic?

The second category attempts to develop investment methods by finding the relationship between fundamental and technical analysis. To be specific, answers to the following questions are sought:

- Does the financial performance of firms affect their stock prices over a long term?
- Is there any relationship between fundamental and technical analysis? Where does technical analysis create better results: firms with strong financial values or poor financial values?

D. BENEFITS

Benefits are related to retirement plans, especially those involving investments in stocks. The results of this research can help increase the return of investments while reducing the risk. In other words, agents or individuals can avoid mistakes while selecting stocks or entering proper time in the market.

These results can also be used by individuals or institutes for investments not related to retirement plans. Moreover, the research concerning price patterns can be used not only in stocks, but in other types of instruments as well, such as forex, futures, options, etc.

E. SCOPE AND LIMITATIONS

The scope of this research is separated into two independent parts. The first part concerns price patterns that could assist investment decisions in the stock market. The results of this section could be used as alerts for making trading decisions, and may be needed for the use of additional tools. The research is limited to the examination of patterns consisting of four candlesticks, and does not include volume information. The second attempts to clarify the relationship between technical and fundamental analysis. The results from this section are very important; they will reveal how technical and fundamental analysis can be combined efficiently to gain the highest return on investment.

Because results are based on data from U.S. stocks, there is a limit to how useful these benefits are. Investments should take place in the U.S. stock market. Before applying this research to foreign markets, the same methods and algorithms that have been applied to data regarding U.S. stocks must be repeated. Although we do not expect any significant variations in case of applying these same methods in foreign markets, methods should be tested.

The research regarding patterns has no limitations of scope. The only requirement is the verification of the defined patterns in other instruments. The second part of research

does have limitations regarding of the type of instruments. It can be applied only for stocks since involves fundamental analysis (Balance Sheet, Income Statement, Ratios, etc).

F. ORGANIZATION OF THE PROJECT

Chapter I – Introduction. This chapter determines where the research can be applied, presents the benefits and research questions, and finally defines the scope and limitations.

Chapter II - Introduction to Candlesticks, Technical and Fundamental Analysis. It explains the role of technical and fundamental analysis and their differences.

Chapter III – Hidden Patterns. The methods and algorithms used to discover hidden price patterns are described. Moreover, it interprets the results and proposes a strategy of efficiently using these results.

Chapter IV - Relationships Between Technical and Fundamental Analysis – Strategies. First, it develops separate strategies for Technical and Fundamental analysis. These strategies, as well as regression analysis, are then applied to samples of U.S. stocks; the results are processed using statistical tools. Finally, it develops a strategy for using both technical and fundamental analysis in the most efficient way.

Chapter V – Conclusion. This section covers both parts of this research and explicitly answers the research questions.

II. INTRODUCTION TO CANDLESTICKS, TECHNICAL AND FUNDAMENTAL ANALYSIS

A. TECHNICAL ANALYSIS

1. Introduction

Technical analysis is the study of market statistics[15] using information of historical prices and volumes to predict future price movements and trends. For calculations, five stock elements are used: Open, Close, High, Low, (Open Interest is only used for futures and options), and Volume (for stocks, this is the number of traded stocks; for futures and options this is the number of contracts). The technical approach is based on three premises[16]:

- Market action incorporates all relevant information. Any information that is political, psychological, or fundamental is reflected in the price of the market.
- Prices move in trends.
- History repeats itself.

The methods of technical analysis can be separated into two categories:

- The visual study of patterns (chart formations, candlesticks) and the construction of various shapes and lines on price charts. The latter part includes the construction of support and resistance lines, trendlines, and channels. This category also includes the study of Fibonacci for drawing shapes (Arc, Fan, Retracement, and Time Zones) and Gann theory (Gann Fan, Gann Grid).
- Development of technical indicators based on historical data. Strategies for producing trade signals (buy or sell decisions) can be developed using proper technical indicators.

15 Leigh Stevens, “Essential Technical Analysis, Tools and Techniques to Spot market Trends”, 3.

16 John J. Murphy , Technical Analysis of the Financial Markets, 2.

2. Price Fields – Bar Charts

Technical analysis involves time series components because each variable is measured over time. Time parameter can be measured by weeks, days, hours, half-hours, quarter-hours, or 5 minute increments, or whatever time unit desired for a study. Variables of tock time series are the following[17]:

- Open: the first trade for a specific time period being studied. If the selected time period is measured by day, then Open is the first trade because the stock market opens.
- High: the highest price that the stock traded during the selected period.
- Low: the lowest price that the stock traded during the selected period.
- Close: the last price that the stock traded during the selected period.
- Volume: the number of shares that are traded during the selected period.

The graphic display of all price elements (Open, High, Low, Close) over a period of time is called a "Bar Chart". The following display depicts a stock in "bar charts" over a period of time.

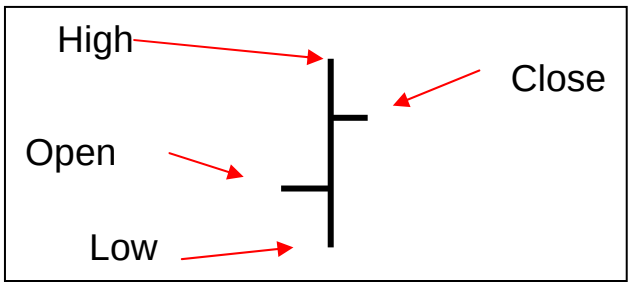

Figure 2. Graphic Display of a Bar Chart

17 Steven B. Achelis, Technical Analysis from A to Z, 9.

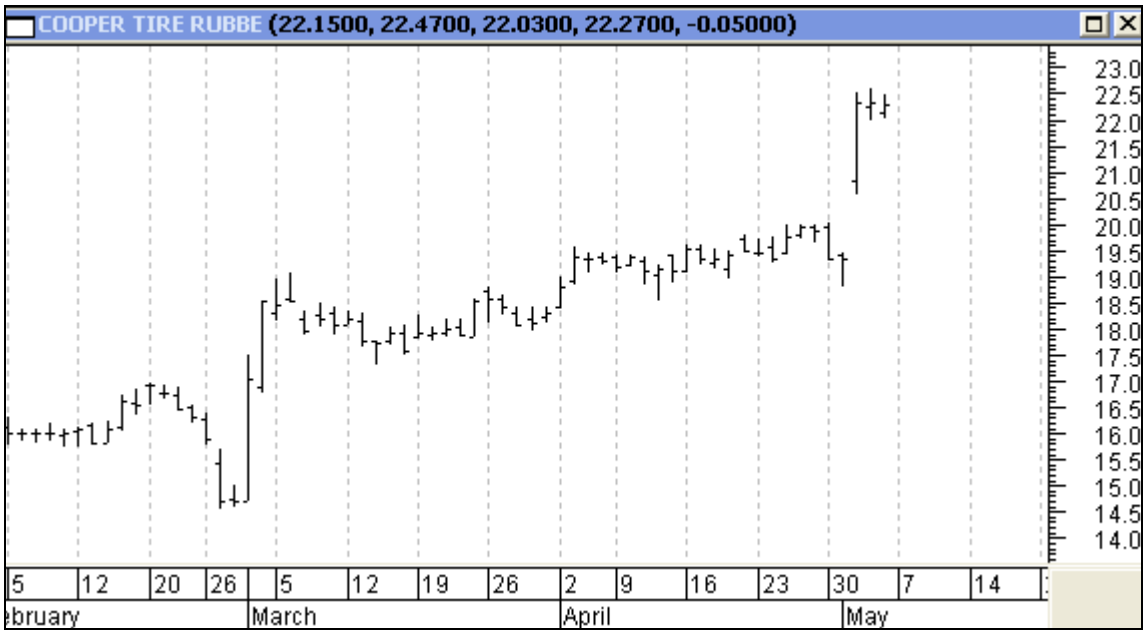

Figure 3. Stock Chart Using Bar Charts[18]

3. Chart Formations

Chart formations or price patterns are divided into two types: reversal patterns and continuation patterns. Both are geometrical representations of prices that can be visually distinguished on the price chart by the investor.

Reversal patterns depict an important change in price trend. They are divided into bottom reversal patterns and top reversal patterns. Bottom reversal patterns should be considered as an opportunity to buy stocks since stock prices move upwards. On the other hand, top reversal patterns present selling signals.

Continuation patterns confirm that current trend will be maintained. It means that stock prices will follow the same trend (up or down). These patterns are different from the reversal patterns, which take more time to build than continuation patterns, and also indicate major trends.

18 Results created by using the Metastock Program, www.equis.com, April 2008.

One of the major and most obvious reversal patterns is the Head (H) and Shoulders (S) pattern. This price pattern, as in the following figure, appears to have a head and two shoulders (left and right) like a person. Generally, it is seen as an up trend, but sometimes as a bottom. Volume is usually highest during the formation of the left shoulder. After the formation of the right shoulder the price drops and the volume increases again. The following figure displays the details of the formation including Volume changes.

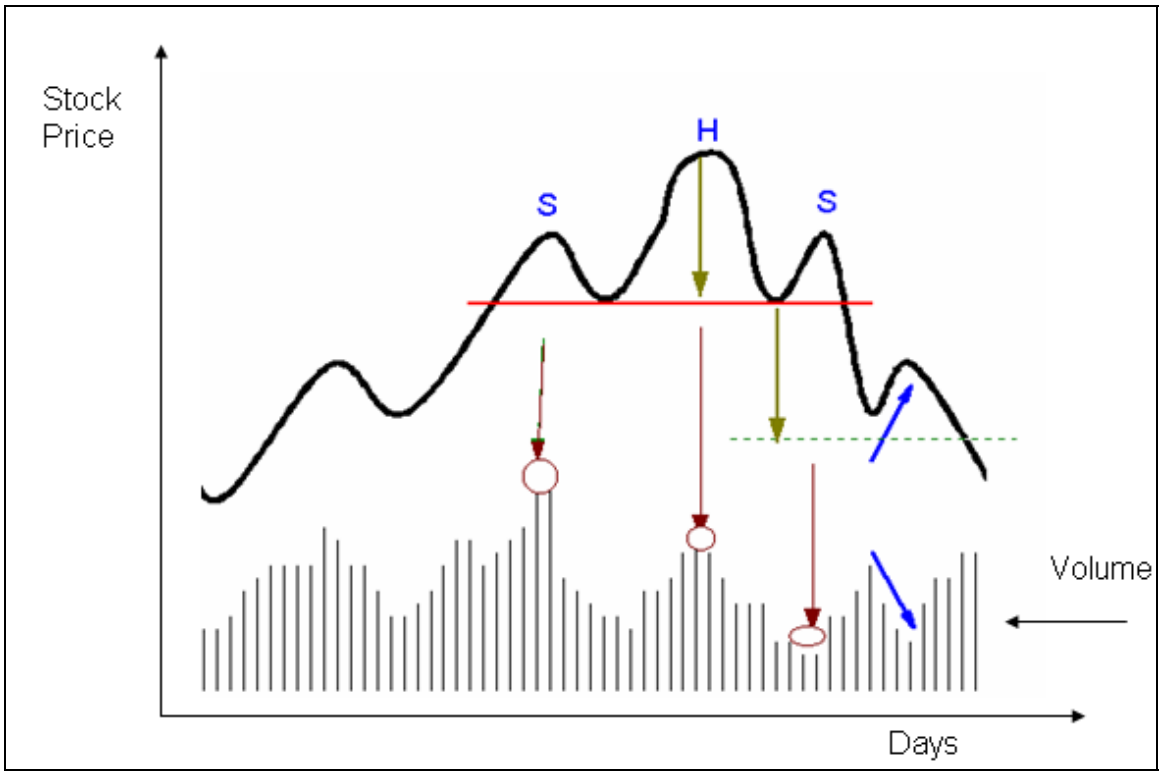

Figure 4. Example of reversal formation: Head and Shoulders

There are usually various reversal patterns, such as variations of head and shoulders patterns, triangles (symmetrical or right angle), wedges, orthodox broadening formations, etc. The most popular continuation patterns are flags and pennants, triangles, and rectangles.

4. Candlesticks

a. Definition

Candlesticks, originated in Japan, are the oldest form of technical analysis used to trade one of the world's first futures markets: "the Japanese rice futures"[19]. Japanese have traded in this market since the 17th century. A Japanese man, Homma, who traded in futures during this period, discovered a link between supply and demand of the rice, which was affected by the emotions of the traders. He utilized his discovery to predict future prices. For centuries this type of trading was kept secret from the West, including America; only in recent years (since 1990s)[20] has it been introduced to public.

Candlestick contains two essential elements: the graphic display, and the interpretation of repeated specific patterns. Its graphic display consists of the body and the shadow or hairs. When the Close value is greater than Open value, the candlestick becomes white. When the Close value is less than Open value, the candlestick becomes black. The line above the body represents the High value, and the line below represents the Low value. Here is a display of white and black candlesticks.

19 Steve Nison, Beyond Candlesticks, 13.

20 Xaris Kourouklis, Technical Analysis, Theory and practice, 343.

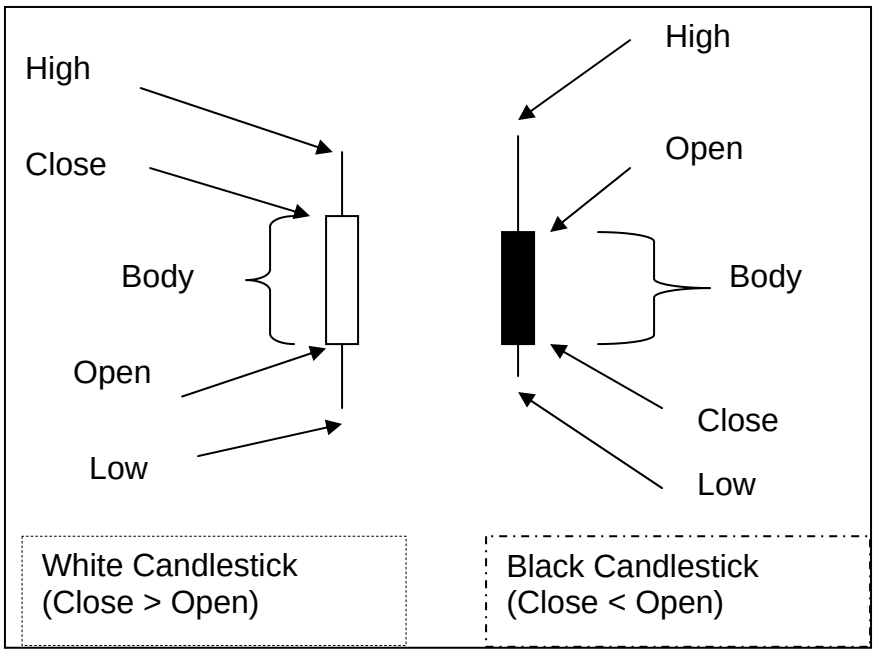

Figure 5. Representation of two candlesticks

Candlestick representation is similar to the representation of bar charts, but candlesticks are easily distinguished and interpreted, and still form specific bearish and bullish patterns. Here are the two different types:

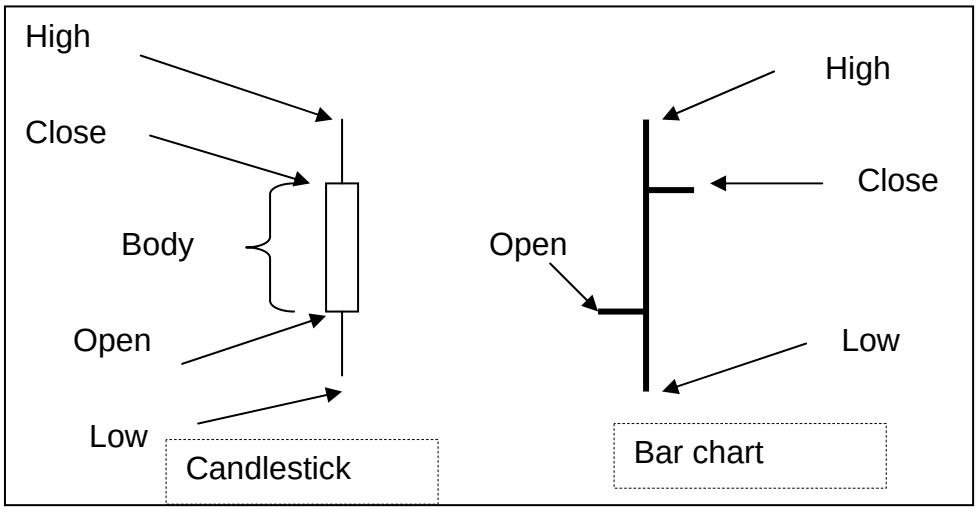

Figure 6. Representation: candlestick & bar chart

The following diagram depicts the forces of demand and supply. In the first case there are more buyers than sellers; as a result, the price of stock is increasing. Buyer demand continues to increase as well as the price.

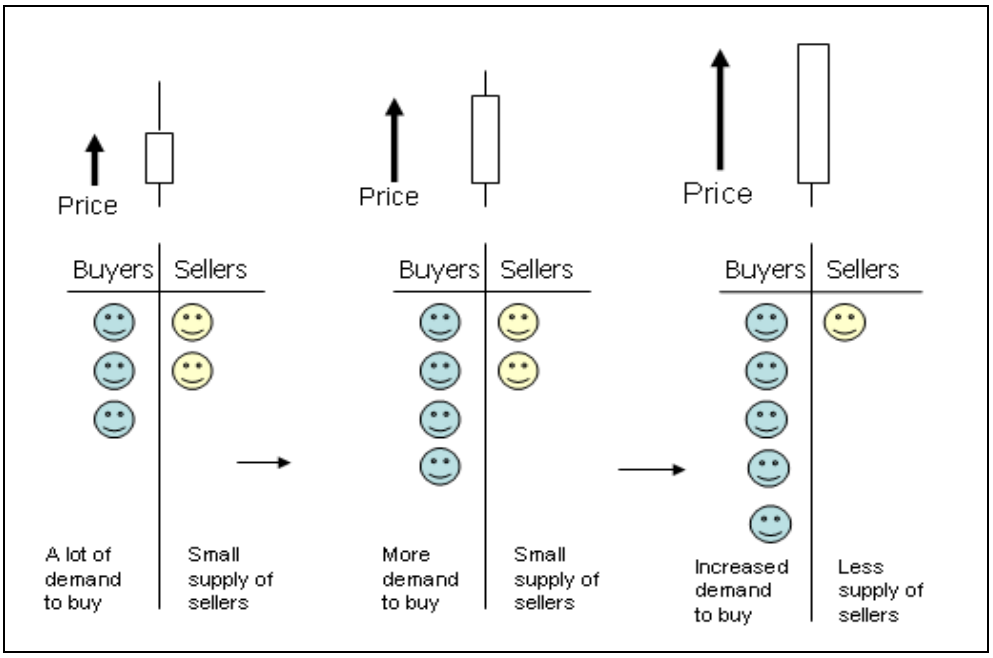

Figure 7. Demand and Supply Forces – Prices up

In the next diagram, there are more sellers than buyers. This causes the stock price to decrease. As the number of sellers increases, the stock price decreases at a greater rate. Therefore, the direction (up or down) of stock prices depends on the balance between demand (buyers) and supply (sellers).

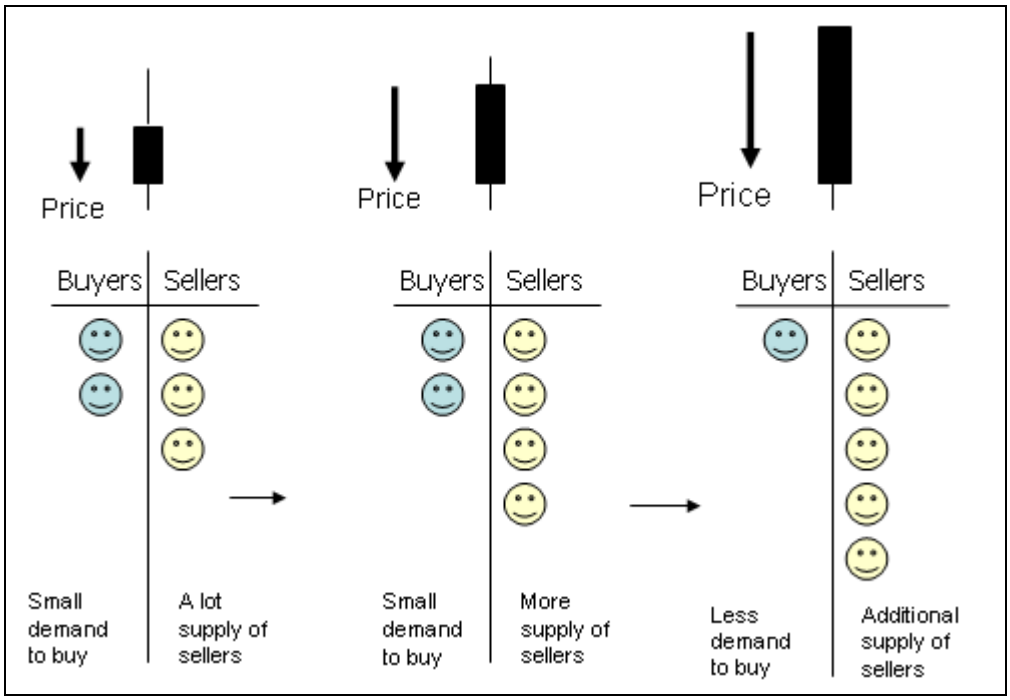

Figure 8. Demand and Supply Forces – Prices down

b. Candlestick Patterns

Two or more successive candlesticks form a pattern. Japanese have named specific candlestick patterns that alert the possibility of a change in direction of prices (reversals). Generally, candlestick patterns are divided into four categories:

- Bullish Reversals, which appear in declining markets and denote the beginning of uptrends.
- Bullish Continuations, which denote the continuation of bullish markets—in other words, provide evidence that we should remain in a trade.
- Bearish Reversals, which appear in uptrend markets and denote the beginning of downtrends.
- Bearish Continuations, which denote the continuation of bearish markets—in other words, they show that we should not remain in the market.

Because this research is meant to find patterns beyond candlesticks, only some of the popular candlestick patterns will be explained.

Hanging man[21]: When this pattern appears during an uptrend market, it denotes a bullish reversal. The Open and Closed values are nearly the same, but the down shadow is large. To ensure that this pattern is bullish, a confirmation is needed the following day. The picture below presents the two cases (confirmed and not confirmed).

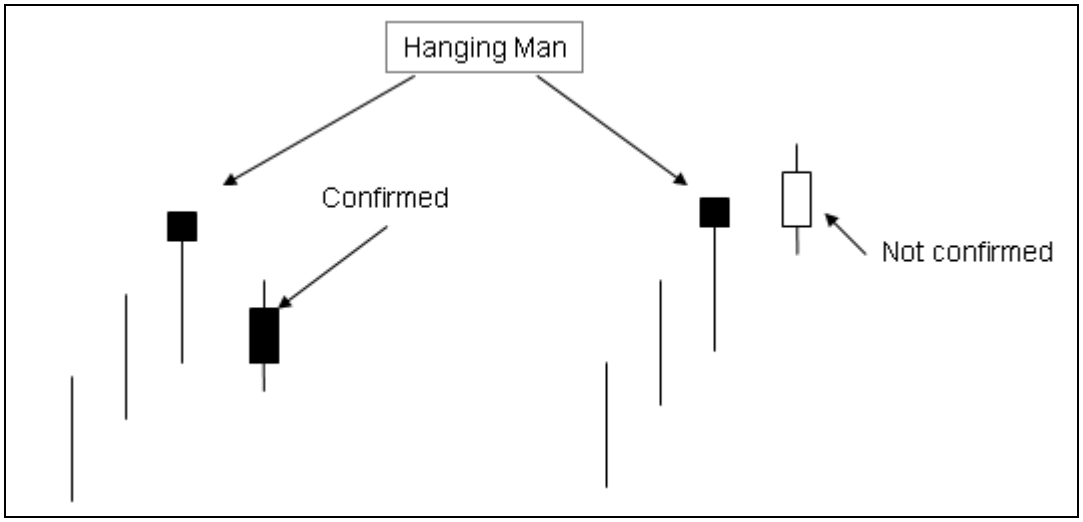

Figure 9. Hanging Man

Star: There are four reversal patterns:

- The Morning Star is a bottom reversal pattern and implies the beginning of increasing prices.
- The Morning Doji Star is a bottom reversal pattern and warns that the declining market will terminate.
- The Evening Star is a top reversal pattern and implies the beginning of a declining market.
- The Evening Doji Star is top reversal pattern and warns that an up trend will be terminated.

21 Steve Nison, Beyond Candlesticks, 59.

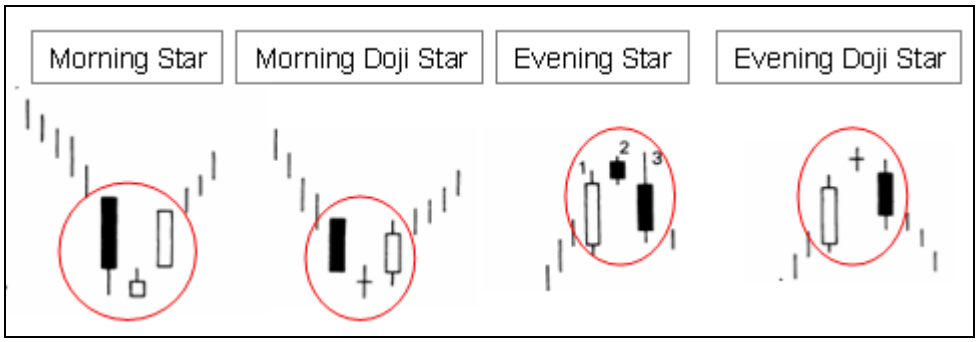

Figure 10. Stars: Four reversal patterns

Dark Cloud: This pattern consists of two candlesticks and appears during an uptrend market. The dark cloud (the black candlestick) denotes a reverse in the market. The reversal confirmation occurs when the volume of the black candlestick becomes greater than the volume of the second.

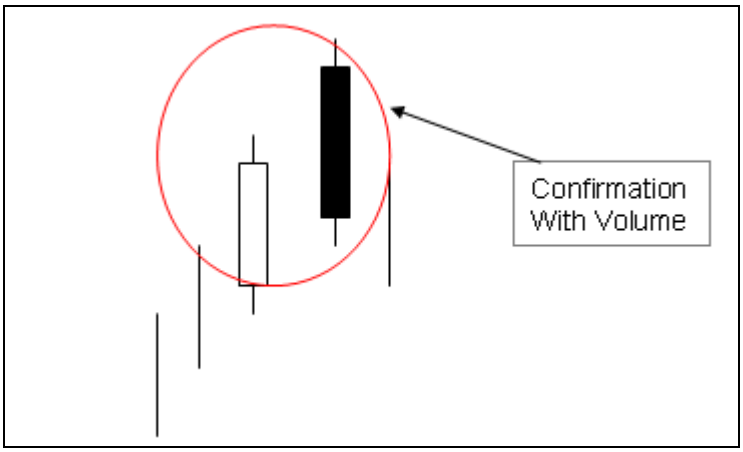

Figure 11. Dark Cloud

Tri-Star: There are two tri-stars. One is a top bearish and appears during an uptrend market. The other is bottom bullish and appears during a downtrend market.

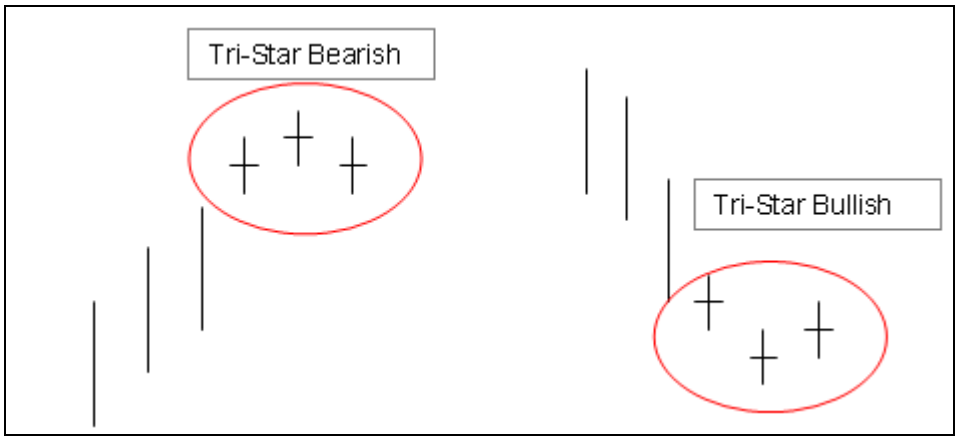

Figure 12. Tri-Star

Harami: This pattern requires that the body of the second day is engulfed by the body of the first day. If it appears during an uptrend market, it denotes a top reversal. Confirmation of increased volume during the following day is required. If it appears during a downtrend market, it denotes a bottom reversal, and the beginning of an up trend.

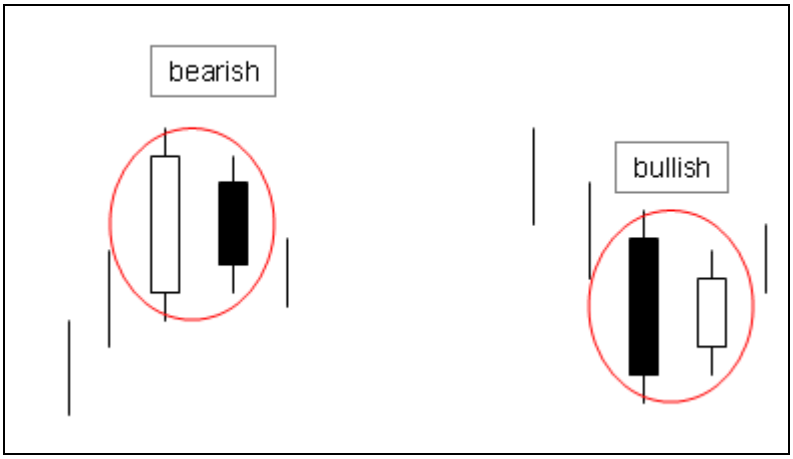

Figure 13. Harami

5. Technical Indicators

A technical indicator is a mathematical calculation of historical price values including Open, High, Low, Close and Volume. Depending on the method of calculations,

indicators fall into six categories[22]: trend indicators, volatility indicators, momentum indicators, cycle indicators, market strength indicators, and support and resistance indicators.

- Trend indicators are used to measure trends and can produce signals (buying or selling).
- Volatility indicators specifically measure the magnitude of day to day fluctuations in prices independent of the direction.
- Momentum indicators measure the speed at which prices move during a given time period. When there is no price trend, they usually provide good results, and also produce overbought and oversold conditions.
- Cycle indicators detect tendencies in cyclical patterns.
- Market strength indicators measure the market strength involved in calculations of volume parameter. They also measure support and resistance.

Technical indicators have at least two types of input parameters. One type involves stock elements (Open, High, Low, Close, and Volume), and the other type determines the time needed for calculations.

6. Trading Systems

Trading systems are rule based systems that use one or more technical indicators to produce trading signals. Depending on the type of indicator, trading signals can be produced in one of the following ways:

- When the indicator value is below stock price, then enter long (buy) otherwise sell. An example is the changing average of stock prices.

22 This categorization is based on the documentation of the Metastock software. It can be found some variations about the categorization or using different names such as Volume Indicators instead of Market Indicators.

- Another case is the production of trading signals by comparing the values of technical indicators and their moving averages. Enter long when the indicator crosses above its moving average otherwise sell.
- Comparison between the technical indicator value with a specific constant value. Enter long when the indicator value exceeds this specific value.
- In oversold situations (stock price is relatively low) enter long and in overbought situations (stock price is relatively high) exit.
- Other conditions.

Trading systems can be validated for specific past periods. There are many tools that support automatic back testing, and calculate its performance. Although the simulation of the trading systems measures effectiveness, it does not guarantee future performance.

B. FUNDAMENTAL ANALYSIS

1. Introduction

Fundamental analysis approaches the decision-making process by attempting to determine the *intrinsic value* [23] of a financial asset. It scrutinizes an issuer's income, expenses, assets, liabilities, management, and position in its industry. Conventional wisdom indicates that the price of an instrument that is trading for less than its intrinsic value should rise, and the price of an instrument that is trading for more than its intrinsic value should fall. Fundamental analysis tells us what *ought* to be the direction of price movements.

23 Intrinsic value is an underlying perception of its true value including all aspects of the business, in terms of both tangible and intangible factors. This value may or may not be the same as the current market value, April 2008, website http://www.investopedia.com/terms/i/intrinsicvalue.asp.

It is very important to understand that stock prices are not the same as a company's financial results; they represent the price agreed upon by sellers and buyers at a particular time. When there are more buyers, then price is driven upward.

To estimate the financial value of a company, many fundamental indicators providing useful information about the current strength of a company and future perspectives (future growth) have been developed. These indicators use data received from a company's balance sheets, income statements and cash flow.

Another popular approach for analyzing financial data is to examine ratios that represent relationships between two or more financial measures. This provides insight into a company's financial condition and efficiency. Ratio analysis addresses four major issues concerning a company:

- Liquidity, which refers to the ability of a company to service its debts. Ratios concerning the relationships between current assets and current liabilities, operating cash flows and current liabilities, and the liquidity of receivables and inventories are included.
- Efficiency, which measures a company's success in managing its asset base. An example is the relationship between of a company's assets and sales, and their conversion.
- Risk, which examines the reliance a company, has on debt to finance its assets.
- Profitability, which measures profits and investments. One popular measure of profitability is the Return on Assets or ROA which is equal to the sum of net income plus interest expense divided by average of total assets.

2. Strategies

Strategies have been developed using fundamental analysis that are similar to technical analysis. The basic idea is to search for companies that are financially strong, but

currently undervalued. This is achieved through the use of special applications called "Stock Screeners," which locate stocks with the best fundamental / financial data. Fundamental data is divided into three categories:

- Historical Financial data. How was the performance of the company during previous years? This category of data is used to find growth concerning various indicators including sales growth, income growth, Earning per Share (EPS) growth, etc.
- Current financial data, usually from the last quarter.
- Future predictions for various financial indicators. There are many estimates provided by experts, who rank stocks based on trends, sector / industry conditions, the efficiency of company's management, etc.

Stock screeners use filters based on fundamental indicators. Values from specific fundamental indicators are compared to specific numbers or averages of specific indicators of a relevant industry. A common mistake is an attempt to find stocks for all sectors simultaneously by filtering fundamental indicators with specific numbers. Compare the following three filter examples, whose purpose is to find

- Stocks from any sector whose Return of Equity (ROE) is greater than 10.
- Find stocks from the "Defense" sector whose ROE is greater than 10.
- Stocks from any sector whose ROE is greater than 1.5 times the average of the sector.

The first example places all stocks in the same metric system. Is this best way to discover healthy stocks? Does ROE have the same meaning for all businesses? Is the same ROE value worth the same amount in both Defense industry and Services? Possibly not. Service companies should have a greater ROE average than the Defense industry because of differences in capitalization.

The second example is more specific. It refers to the same type of companies, which can therefore be compared. Fundamental indicators have different meanings when they are applied to different sectors. But what is the best way to search stocks independent of the sector?

The third example is a good approach because it searches for stocks based on the average value of the industry or sector in which the stocks belong. It finds the best stocks of each industry without using specific values.

Supposing that the best financially performing stocks have been found, which of these stocks are undervalued? This is very difficult question, and many strategies have been developed to find the answer. Some of them use the following strategy to produce signals (buy or sell):

- Use Ratio (Share Price / Book Value per Share). If the result is less than 1, then the share is undervalued and this share should be purchased. If the result is above a certain point, such as 4, then the share is overvalued and the share should be sold.
- Price-Earning Ratio (P/E Ratio). P/E Ratio[24] is equal to Market Value per Share divided by Earnings per Share (EPS). High P/E values depict investor expectations of higher earnings in futures than for companies with lower P/E. For example if the P/E ratio is 20, investors are willing to pay $20 for each dollar of the previous earnings. The value of P/E used depends on the type of sector/industry, as well as an avoidance of stocks with low P/E ratios.
- Technical analysis can assist in determining the exact time of buying and selling shares.

It is uncertain if selecting data by filtering stocks based on fundamental indicators will work. It is also uncertain if these strategies can be compared.

24 Investopedia Encyclopedia, April 2008, www.investopedia.com.

Therefore, the only method that can be used is back-testing. Although past performance is not a guarantee of future results, it is better to use strategies that have been proven to be profitable in history. There is software available on the market which, in addition to screening stocks, supports back testing for fundamental strategies.

One of the best suppliers of software tools for back-testing is the "ZACKS Investment Research" [25]company. The following is an example of back-testing:

Return on Equity (ROE) Strategy: investing in stock portfolios that are based on the following screening criteria:

- ROE >= 10
- Zack's Rank = 1 (It is based on earning estimates a value of 1 means that a stock has the strongest buy signal)
- Price/Sales <=1 (stock undervalued)
- Stock Price >$5

Stocks that do not satisfy the conditions above are deleted from the portfolio and replaced by stocks that do. Displayed below are the results of back testing found by Zack's Research:

25 This company offer services for investments in the stock market while supports back-testing, May 2008, http://www.zacks.com/.

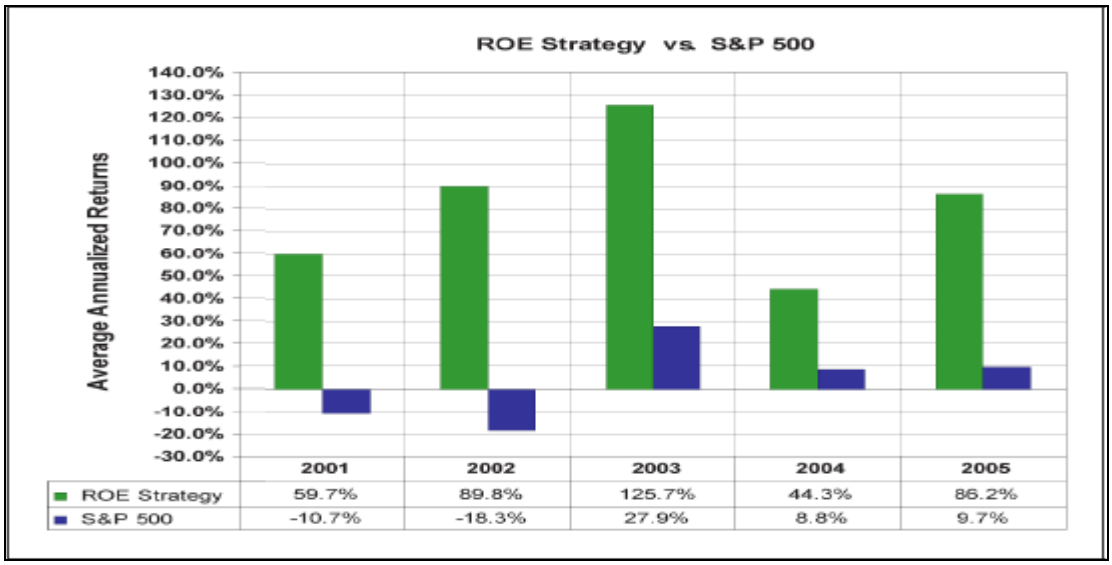

Figure 14. Results of using the Zack's Research Wizard Program

In Figure 14, we can observe that ROE strategy brought greater annual returns than the index S&P 500. In 2003 the annual return of S&P 500 was 27.9% while the ROE strategy brought the greatest annual returns. Moreover, although the annual return of S&P 500 in years 2001 and 2002 was negative, the ROE strategy's return was positive.

3. Differences with Technical Analysis

Although technical analysis has been used for investing in the stock market for many decades, it has not received the same recognition[26] as fundamental analysis from scholars. Some academics do not recognize technical analysis such as Burton Malkiel argues, "Technical analysis is anathema to the academic world"[27]. On the other hand, some Federal Reserve and academic studies include evidence that supports technical analysis. MIT finance professor Andrew Lo argues that[28] "several academic studies suggest that technical analysis may well be an effective means for extracting useful

26 Andrew W. Lo, Harry Mamaysky and Jiang Wang, "Foundations of Technical Analysis" The Journal of Finance, Vol LV, No 4, August 2000.

27 The Hedge Fund Consistency Index, May 2008, http://www.hedgefund-index.com/d_technicals.asp.

28 Emmanuel Acar & Stephen Satchell, Advanced trading rules, second edition, 42.

information from the markets". The differences between technical and fundamental analysis can be summarized as the following:

- Both use different types of historical information. A fundamental approach employs information regarding dividend rates, sales, income, ratios, etc; technical analysis uses only simple information such as price elements and volume.
- Fundamental analysis views the prices of a stock related to the intrinsic value (undervalued or overvalued); technical analysis is based on prices and trends.
- Fundamental strategies are applied to long periods of time (months); technical analysis is applied to short periods of time (minutes, hours, days).
- Technical analysis is generally more sensitive to prices changes. It can produce many signals (buy or sell) during a day trade.

Technical and fundamental analyses are complementary investment strategies. For better results, both types of analysis should be applied.

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III. HIDDEN PATTERNS

A. KNOWLEDGE REPRESENTATION MODEL

1. Model Description

Chart formations and candlesticks have been analyzed in depth and used by many investors in the Stock Market, especially for short term investments. One of the purposes of this research was to discover if other types of price formations existed which could assist in trading decisions, and how these other types performed. An early resource was a research paper from Southern Illinois University[29],which found some interesting new stock price patterns.

In order to develop an algorithm for discovering new price patterns, a proper model of knowledge representation should be constructed. This model should hold information referring to candlestick elements (Open, Close, High, and Low) and its relationship to neighbor candlesticks. Developing a knowledge representation model requires the following steps:

- Step 1: Select the stock data, including all elements referring to a specific period of time.
- Step 2: Define the specifications of the model. The information that should be collected and translated must include
    - Candlestick elements(Open, Close, High, Low),
    - Gaps,
    - Relationships between neighbor candlesticks. This research has examined two types of relationships: patterns of three candlesticks and patterns of four candlesticks.

29 Yihua Philip Sheng, Wen-Chi Hou, Zhong Chen, "Mining for Profitable Patterns in the Stock Market", Southern Illinois University USA, 2001.

- Step 3: Construct a translation system to hold all relevant data according to the specifications of the model. Here, this is needed to create rules based on specific conditions and price elements such as ‘Open’. Each rule should produce a binary digit (0 or1). For example, if the current Close element is greater than the current Open value then return ‘1’ or return ‘0’.
- Step 4: Using simple rules, develop a translation system which produces three or four patterns. The translation system should actually consist of specific rules that are applied in a specific order to produce the patterns.
- Step 5: The final product is a binary number ready for further process.

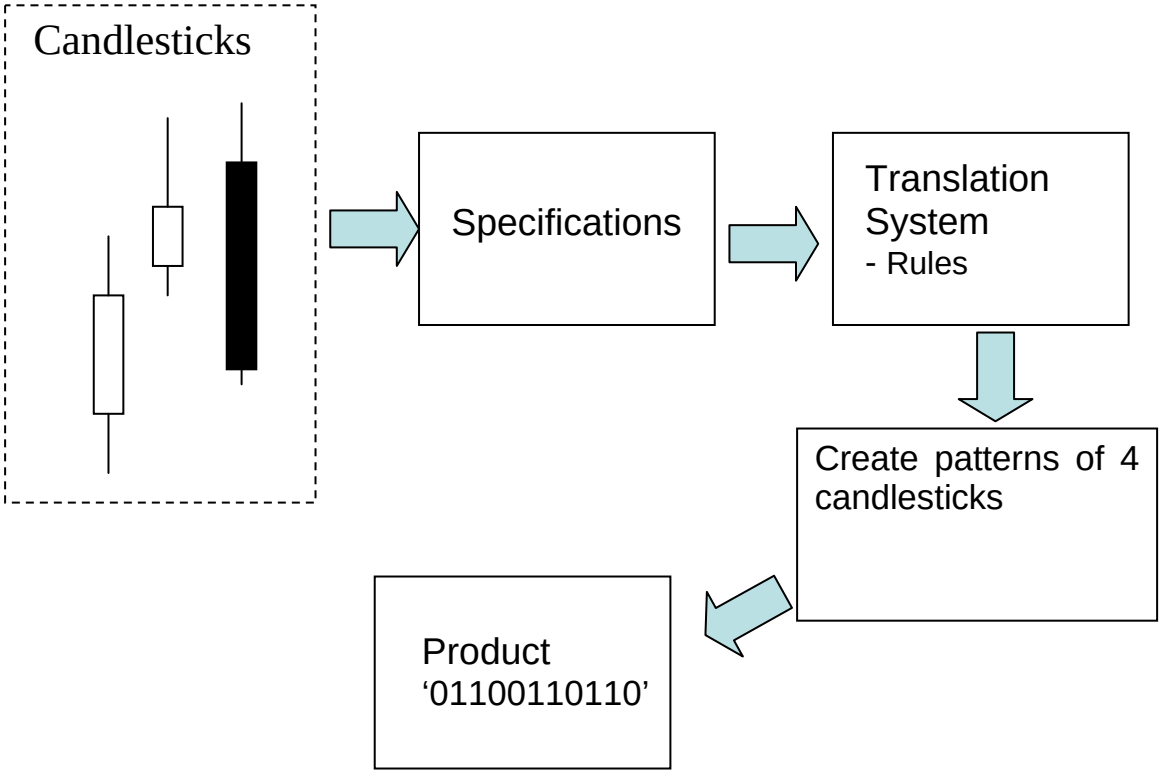


Figure 15. Knowledge Representation Model

2. The Translation System’s Rules

Two types of rules have been developed:

- Rules concerning only one candlestick on specific date.

- Rules concerning the relationship between two consecutive candlesticks.

a. Rules of One Candlestick

Rule 1 / Bit Position 1: Define the type of candlestick, is it white or black?

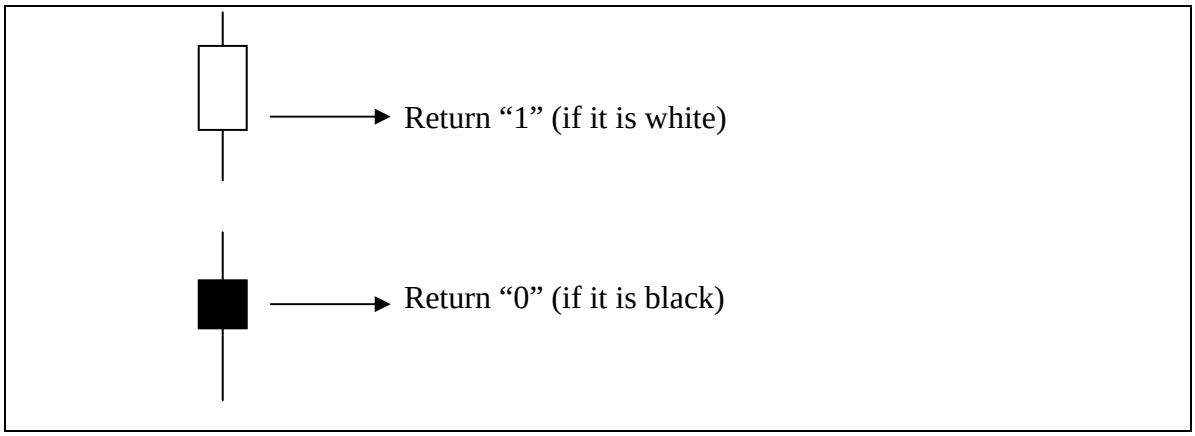
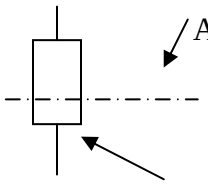
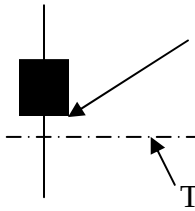


Figure 16. Graphical display of rule 1

Rule 2 / Bit Position 2: Is the bottom of the candlestick body greater than the average high and low price? If it is, then return “1”; if not, return “0”. (compare Body Down with (High + Low)/2)



Body Down is lower than the middle of the candlestick. So, it returns “0”



The Body Down is upper than the middle of the candlestick. So, it returns “1”

The average of high and low

Figure 17. Graphical display of rule 2

Rule 3 / Bit Position 3: If the upper body is lower than the average high and low price then return “1”; if not, return “0”.

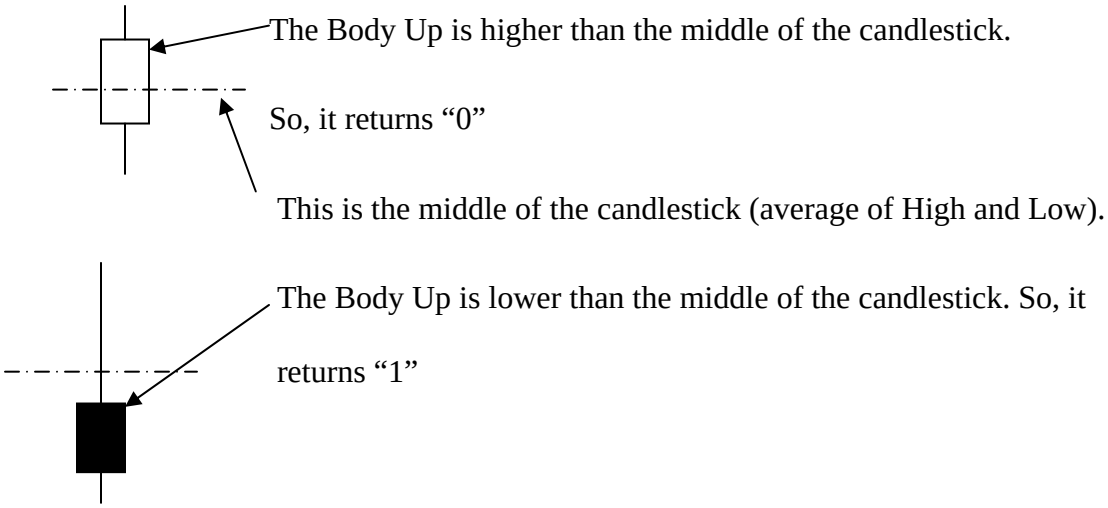


Figure 18. Graphical display of rule 3

Rule 4 / Bit Position 4: It compares the shadow size up the body size. If the shadow size up is greater than the body size, return ‘1’; if not, return ‘0’.

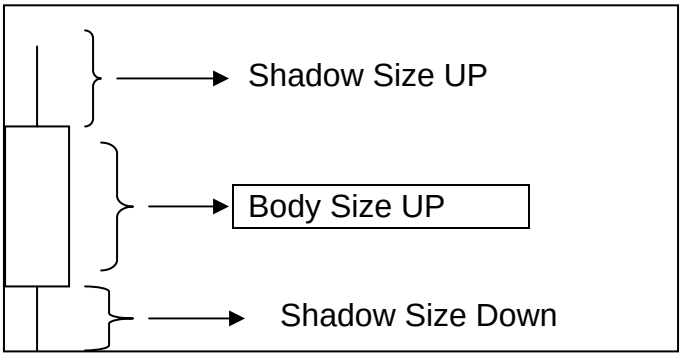


Figure 19. Graphical display of rule 7

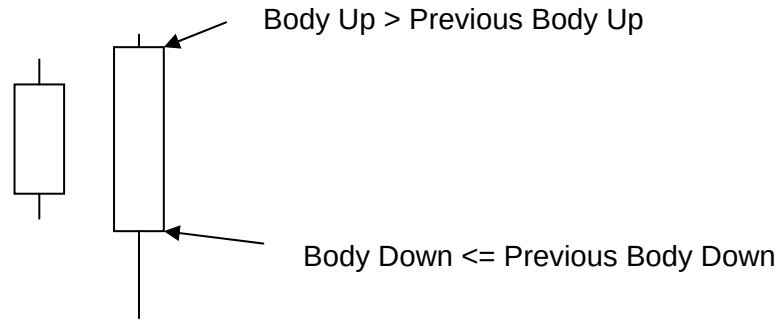
Rule 5 / Bit Position 5: Compares the shadow size down to the body size. If the shadow size down is greater than the body size, return ‘1’; otherwise, return ‘0’.

b. Relationship Rules Between Two Candlesticks

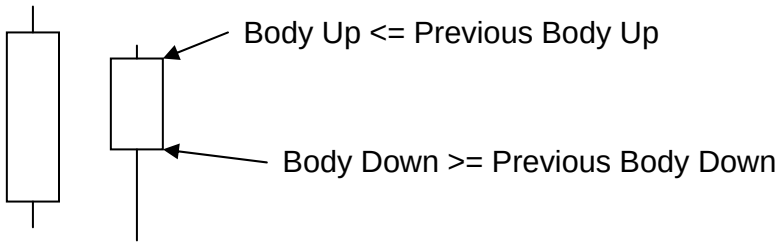
Rule 6 / Bit Position 6: compares the closed value with the previous values. If the current closed value is greater than the previous day's close, return "1"; otherwise, return "0".

Rule 7 / Bit Position 7, 8 and 9: takes into account the exact position between two candlesticks. The following figures represent the different relative positions between two successive candlesticks:

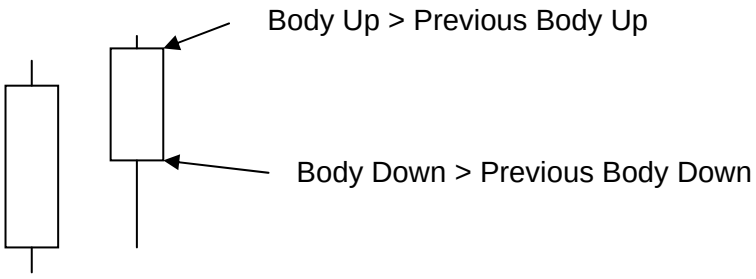
Return "001"



Return "010"



Return "011"



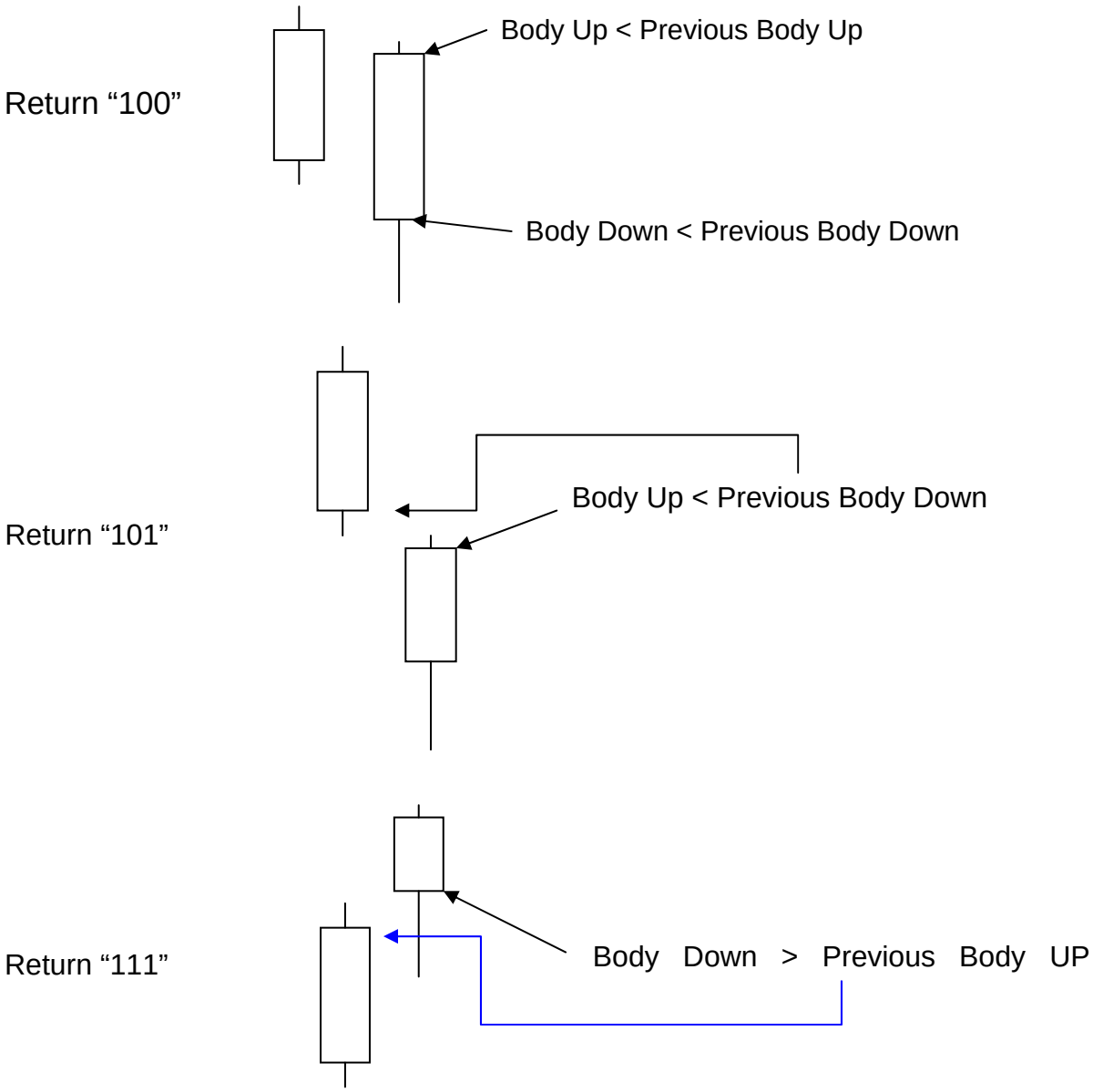


Figure 20. Graphical display of rule 12

3. Developing the Codification Systems

a. Developing the Component Parts

The first step of developing component parts is the construction of simple components for patterns frames, and combines them to form the patterns of 4 candlesticks.

As explained in previous paragraphs, the rules can be divided into two categories: rules concerning a candlestick itself, and rules concerning the relationship between two candlesticks. Supposing that "DayID" represents the current day, "DayID – 1" represents one day ago, "DayID -2" represents two days ago, the following simple components were developed:

- Components of part A (referring to the candlestick itself)
  - Pattern A: contains all rules referring to a candlestick itself. The result is a string type (like "10011") produced by uniting each bit from the rules. The total length is 5 bits and the algorithm is the following calculation:

Pattern A = Unite (Bit From Rule 1 + Bit From Rule 2 + Bit From Rule 3 + Bit From Rule 4 + Bit From Rule 5).

- Components of part B (referring to relationships)
  - Pattern B: contains all rules referring to the relationship between two candlesticks. The total length is 4 bits. The algorithm is the following calculation:

Simple Type 2 Pattern B = Unite (Bit From Rule 6 + Bit From Rule 7).

b. Combining the Components

The next step is the development of algorithms for combining the above components in order to produce the codification systems. The following is the algorithm for producing the system:

- Pattern of four elements. The formula is the following:

Product = Component of pattern A(DayID – 3) + Component of pattern A(DayID – 2) + Component of pattern A(DayID – 1)+ Component of pattern A(DayID) + Component of pattern

B(DayID – 2) + Component of pattern B(DayID – 1) + Component of pattern B(DayID)

c. The FinalAalgorithm

After developing the algorithms to create the binary type patterns, then a processing algorithm for examining the data patterns must be developed. This algorithm's main steps are

- Obtain the data of the candlestick and volume for a specific day (Open, High, Low, and Close), and apply the codification system algorithm to create all possible patterns (a total six binary numbers). Save these values and repeat the same procedure for the next days.
- After the creation of the above data, group the data separately for each type of pattern.
- The last step is the proper processing of the data. For each type of pattern, the following information is obtained in advance:
    - Occurrence times of this pattern.
    - What happened the next day when this pattern occurred. Estimate the possibility of increased stock prices by dividing the occurrence times of increasing prices for the next day by the total times of occurrence for this pattern. The same procedure is repeated for the next 15 days. The following is the formula for the next day 'x':

Probability of a stock increasing at the end of the x^{th} day = (count the times of Close value of the next the x^{th} day is greater than current Close value) / (total times of this pattern occurrence).

Probability of stock to decrease at the end of the x^{th} day = 1 - Probability of stock to increase at the end of the x^{th} day.

The next two diagrams depict the analytical steps of the final algorithm.

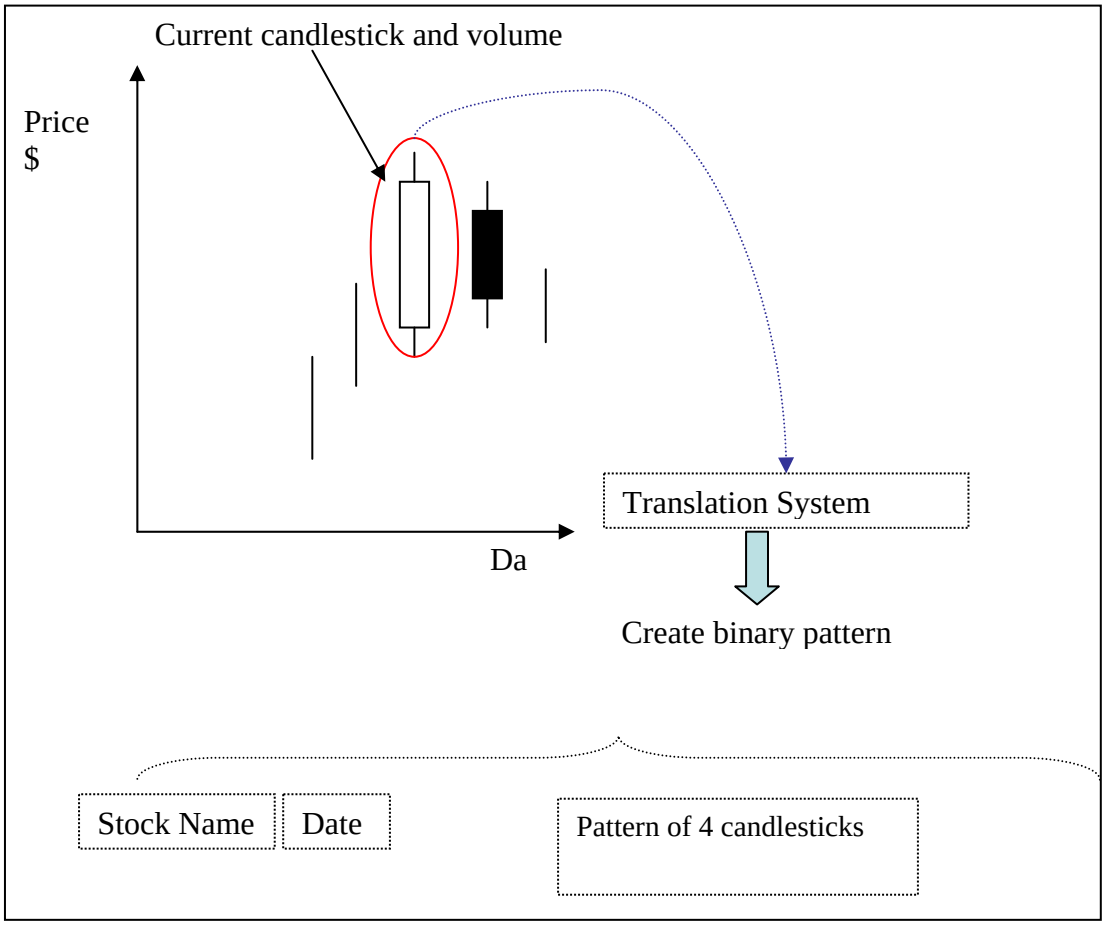


Figure 21. Step 1: The creation of patterns

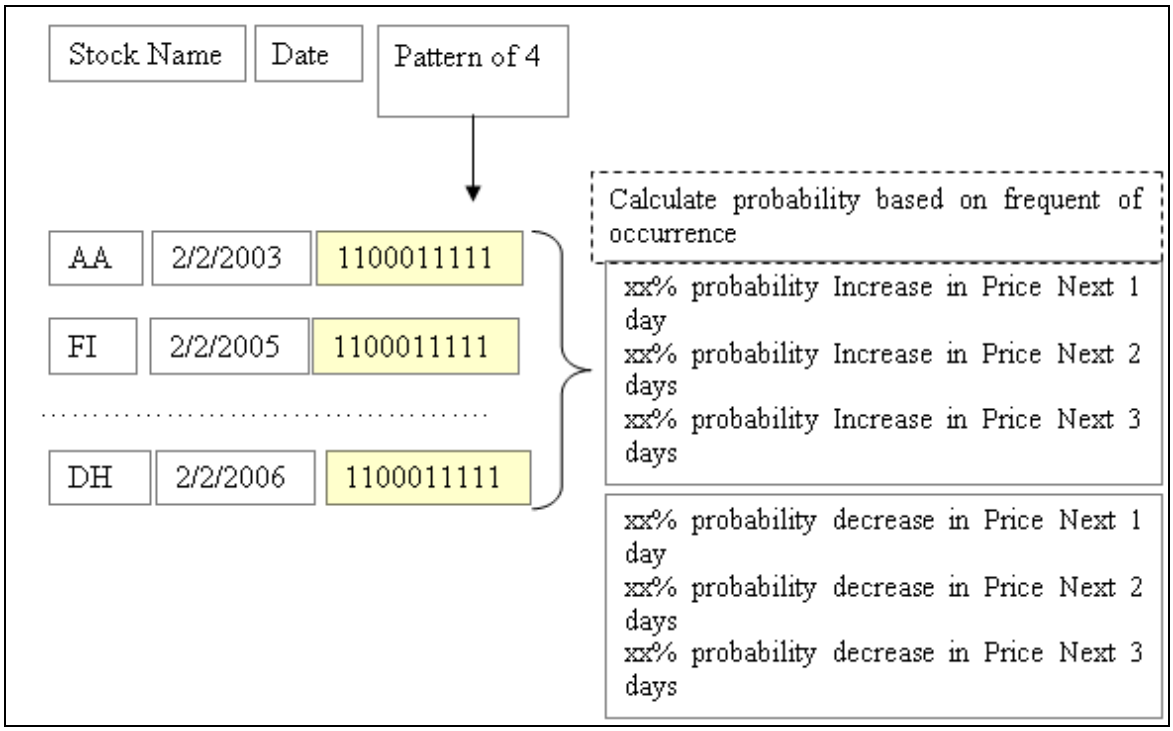


Figure 22. Steps 2 and 3: Group and process patterns

The process of the data extracts useful information about the direction of stock prices for the next days. The work is focused on two main points:

- Find the bullish patterns corresponding to the next days.
- Find the bearish patterns corresponding to the next days.

B. RESULTS

1. Best Predictions for Specific Bullish Days

Patterns that result in the best prediction of prices to increase at a specific time (one of the next 1-10 days) are extracted. Extracted patterns successfully predict at a high rate the specific day that a stock's price will increase. This table contains the specific pattern, frequency, and percentage of the possibility for the stock price to increase. The

90% possibility for day 2 means that if the pattern appears 100 times, then the stock price will increase at specific day (next day 2) 90 times.

	Pattern Code	Frequency	% Probability of Price to Increase
Day +1	10000000000000010111001001000100	19	94.74
Day +2	10110100001000000000100110110100	20	90
Day +3	00000110110000010000101001001001	21	90.48
Day +4	10110101110000000000101101000100	19	94.74
Day +5	10000010111000000000101110010010	18	88.89
Day + 6	00000101110000010000101001001010	18	94.44
Day +7	00000101110000010000101001001010	18	94.44
Day +8	00000101110000010000101001001010	18	94.44
Day + 9	01001000000000000000010000010100	17	94.12
Day + 10	00001000000001100000010001000100	16	93.75

Table 1. Best Bullish Predictions at Specific Day

The next table analyzes the probability of prices increasing beyond a specific value (0%, 3%, 6%, and 12%). The values refer to the best prediction corresponding to patterns that have a frequency greater than 14 (>=15).

	Maximum probability - frequency of patterns >=15			
	Price > 0%	**Price > 3%**	**Price > 6%**	**Price > 12%**
Day +1	94.7	40.0	25.0	12.5
Day +2	90.0	50.0	31.3	18.8
Day +3	90.5	53.3	33.3	20.0
Day +4	94.7	62.5	43.8	22.2
Day +5	88.9	68.8	52.9	27.8
Day + 6	94.4	66.7	43.8	31.3
Day +7	94.4	63.2	46.7	37.5
Day +8	94.4	75.0	53.3	33.3
Day + 9	94.1	75.0	53.3	33.3
Day + 10	93.8	81.3	60.0	33.3

Table 2. Best Bullish Predictions Analysis

The next figure depicts the probabilities of stock prices increasing beyond the specific values. It is the graphic display of the previous table.

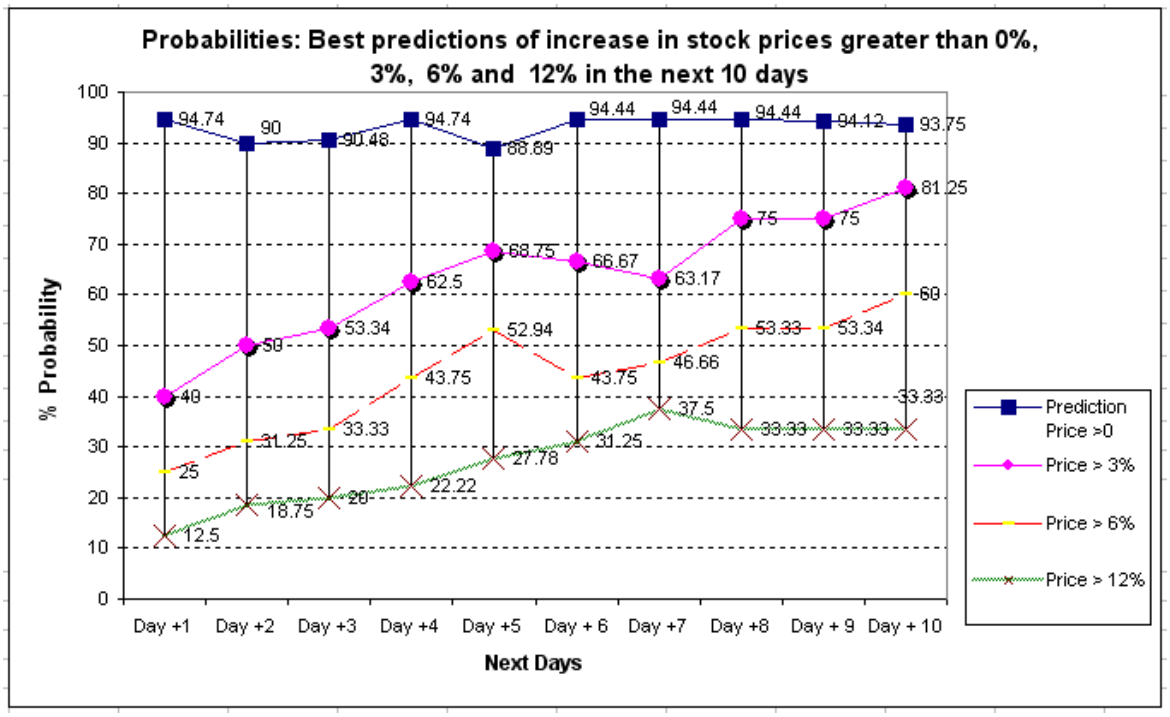


Figure 23. Best Bullish Prediction Details

The next tables depict the number of bullish patterns found and correspond to the above specific probabilities. The number of patterns corresponding to high probability (greater than 80%) is small, which means that these patterns appeared rarely, and cannot be used daily.

	Number of Different Patterns Found		
	Probability >80%	**Probability >70%**	**Probability >60%**
Day +1	13	114	214
Day +2	26	152	215
Day +3	22	158	215
Day +4	32	189	248
Day +5	37	181	215
Day + 6	33	219	305
Day +7	40	103	233
Day +8	44	240	248
Day + 9	46	257	253
Day + 10	48	249	253

Table 3. Number of Bullish Patterns Per Day

2. Best Predictions for Specific Bearish Days

Similar steps are followed similarly with previous predictions by extracting patterns that result in the best prediction of price decreases on a specific day (one of the next 1-10 days). The extracted patterns successfully predict at a high rate that stock prices will decrease on specific days in the future. This table contains the specific pattern, frequency of, and percentage of the probability of a stock price increasing.

	Pattern Code	Frequency	Probability of Price to Decrease
Day +1	00011000000000011001010001001010	15	86.67
Day +2	00000000001000011011010011000010	18	83.33
Day +3	10000100001001010000101100101011	17	88.24
Day +4	10000000001000010010010010111011	17	88.24
Day +5	11001100001001010000101110111011	18	88.89
Day + 6	00110100000000001000010110011100 1	22	81.82
Day +7	01001000001000010011010010111011	16	87.50
Day +8	00001001101000010000010010111011	16	87.50
Day + 9	00001001101000010000010010111011	16	93.75
Day + 10	00001001101000010000010010111011	16	87.50

Table 4. Best Bearish Predictions at Specific Day

The next table analyzes the probability of prices decreasing below a specific value (0%, -3%, -6%, and -12%). The values refer to the best prediction corresponding to patterns which have a frequency greater than 14 (>=15).

	Maximum probability - frequency of patterns >=15			
	Price < 0%	Price < -3%	Price < -6%	Price < -12%
Day +1	86.67	40.00	20.00	13.33
Day +2	83.33	53.33	26.09	14.29
Day +3	88.24	53.34	31.58	18.75
Day +4	88.24	52.63	36.84	20.83
Day +5	88.89	56.25	43.75	25.00
Day + 6	81.82	62.50	43.75	30.00
Day +7	87.50	57.89	43.75	26.32
Day +8	87.50	63.16	43.75	31.58
Day + 9	93.75	60.00	50.00	31.58
Day + 10	87.50	60.01	53.34	31.58

Table 5. Best Bearish Predictions Analysis

The next figure depicts the probabilities of decreasing stock prices below the specific values. It is the graphic display of the previous table.

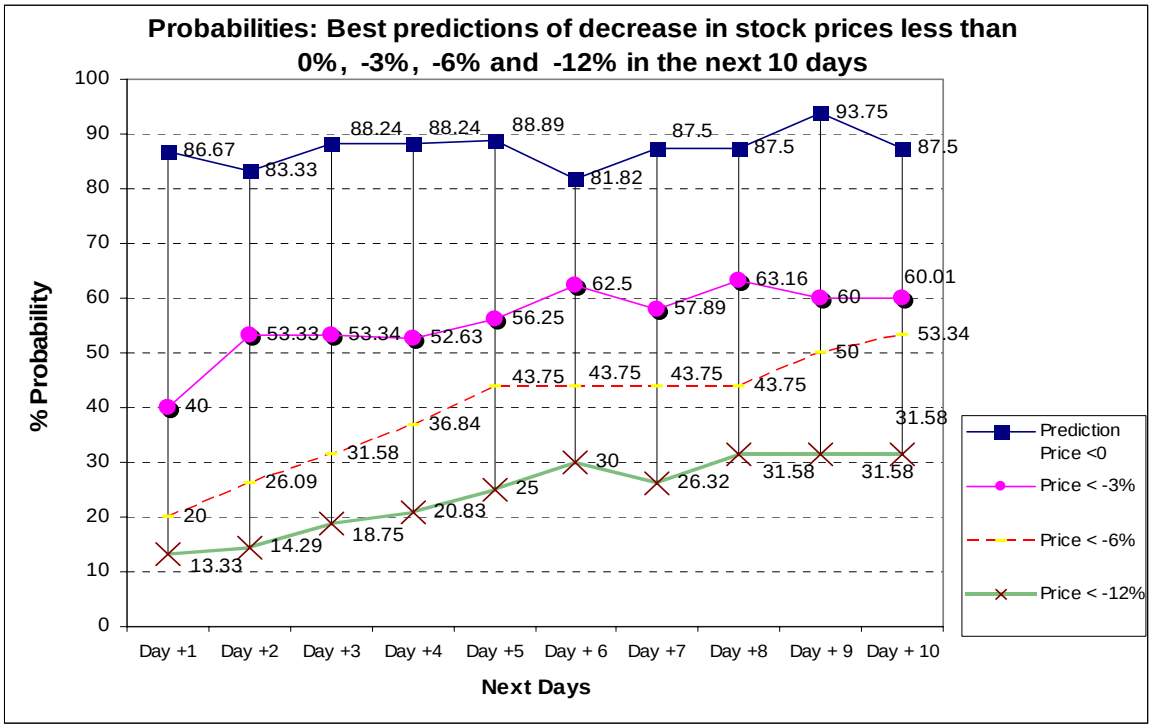


Figure 24. Best Bearish Prediction Details

The next tables depict the number of bearish patterns found, and correspond to the above specific probabilities. The number of patterns corresponding to high probability is small and therefore cannot be used daily. The number of bearish patterns is less than the number of bullish patterns corresponding to the same range of probability.

	Number of different patterns found		
	Probability >80%	**Probability >70%**	**Probability >60%**
Day +1	14	114	126
Day +2	13	90	126
Day +3	14	56	76
Day +4	9	74	110
Day +5	6	79	110
Day + 6	6	65	110
Day +7	6	53	110
Day +8	9	64	83
Day + 9	9	64	89
Day + 10	8	70	71

Table 6. Number of Bearish Patterns Per Day

3. Strong Bullish Continuation Patterns

Patterns that depict the continuation of a strong uptrend for the next 10 days can be characterized as strong bullish patterns because they depict a high probability that stock prices will increase. The average of probability is 73.6%, while the number of different patterns found is 29. The next table represents the probability of the stock price increasing during next 10 successive days.

FREQ	Pattern of Four Candlesticks	Next 1	Next 2	Next 3	Next 4	Next 5	Next 6	Next 7	Next 8	Next 9	Next 10
24	00000100000000000111110001000100	66.7	83.3	79.2	75.0	70.8	79.2	66.7	70.8	66.7	62.5
24	10000100111000011001101110111011	62.5	75.0	79.2	79.2	79.2	70.8	70.8	66.7	75.0	70.8
24	10000100001001000000101110110011	66.7	79.2	66.7	70.8	62.5	66.7	66.7	62.5	70.8	75.0
23	00000101100000010000101000011010	78.3	65.2	60.9	69.6	69.6	78.3	73.9	69.6	69.6	65.2
21	00000110110000010000101001001001	81.0	81.0	90.5	71.4	66.7	76.2	71.4	61.9	81.0	81.0
21	00000000001011000000010010110001	61.9	76.2	76.2	90.5	71.4	71.4	81.0	81.0	71.4	81.0
20	10000100000000010001101101001100	70.0	75.0	70.0	65.0	80.0	75.0	80.0	80.0	80.0	80.0
19	10110101110000000000101101000100	79.0	84.2	84.2	94.7	84.2	73.7	73.7	84.2	73.7	63.2
19	00000100001000000110110010110011	63.2	68.4	73.7	84.2	79.0	68.4	68.4	79.0	73.7	79.0
18	10000000000001100000001110100100	61.1	72.2	72.2	66.7	72.2	83.3	88.9	77.8	72.2	77.8
18	10111100000000010000101101001011	66.7	72.2	77.8	66.7	77.8	72.2	72.2	72.2	66.7	72.2
18	01011000100000000000010001000100	61.1	72.2	77.8	77.8	77.8	77.8	72.2	72.2	83.3	66.7
18	00000101110000010000101001001010	61.1	61.1	77.8	83.3	83.3	94.4	94.4	94.4	88.9	88.9
18	10000110011001100000101110110001	61.1	77.8	61.1	72.2	77.8	72.2	72.2	72.2	77.8	77.8
17	00000101111000010110101010111011	70.6	88.2	76.5	76.5	70.6	70.6	70.6	70.6	76.5	70.6
17	10111100110000000000101100010100	64.7	76.5	64.7	76.5	64.7	76.5	76.5	70.6	64.7	64.7
17	10011000000000000110000101000100	82.4	70.6	70.6	64.7	76.5	76.5	82.4	82.4	88.2	82.4
17	00000110111000010111101010111011	76.5	64.7	64.7	76.5	76.5	70.6	64.7	70.6	70.6	64.7
16	00110000001000010011010010111011	75.0	68.8	75.0	75.0	68.8	75.0	75.0	75.0	75.0	75.0
16	10110101110000000000101100010100	68.8	62.5	62.5	81.3	75.0	68.8	75.0	75.0	81.3	87.5
16	00011100001000000111101110110010	62.5	68.8	68.8	68.8	75.0	75.0	68.8	75.0	75.0	75.0
16	10000000001101100000001010100100	81.3	68.8	75.0	62.5	68.8	62.5	75.0	68.8	75.0	75.0
16	00000010110000001011010001000100	62.5	68.8	68.8	68.8	75.0	81.3	75.0	81.3	81.3	75.0
16	10000001100000000110001001000100	81.3	81.3	81.3	62.5	62.5	62.5	75.0	81.3	62.5	68.8
16	10000000001000010110000110101011	62.5	81.3	75.0	93.8	75.0	81.3	81.3	81.3	68.8	68.8
15	10000000001011010000010010111011	86.7	73.3	66.7	66.7	73.3	66.7	73.3	80.0	80.0	73.3
15	10000110110000000000101101110100	73.3	73.3	73.3	66.7	66.7	66.7	66.7	73.3	66.7	80.0
15	00000001100000000000101101000100	73.3	80.0	73.3	73.3	66.7	66.7	73.3	73.3	73.3	66.7

Table 7. Strong Bullish Continuation Patterns

The average of probabilities of all the above patterns per day is displayed in the next figure:

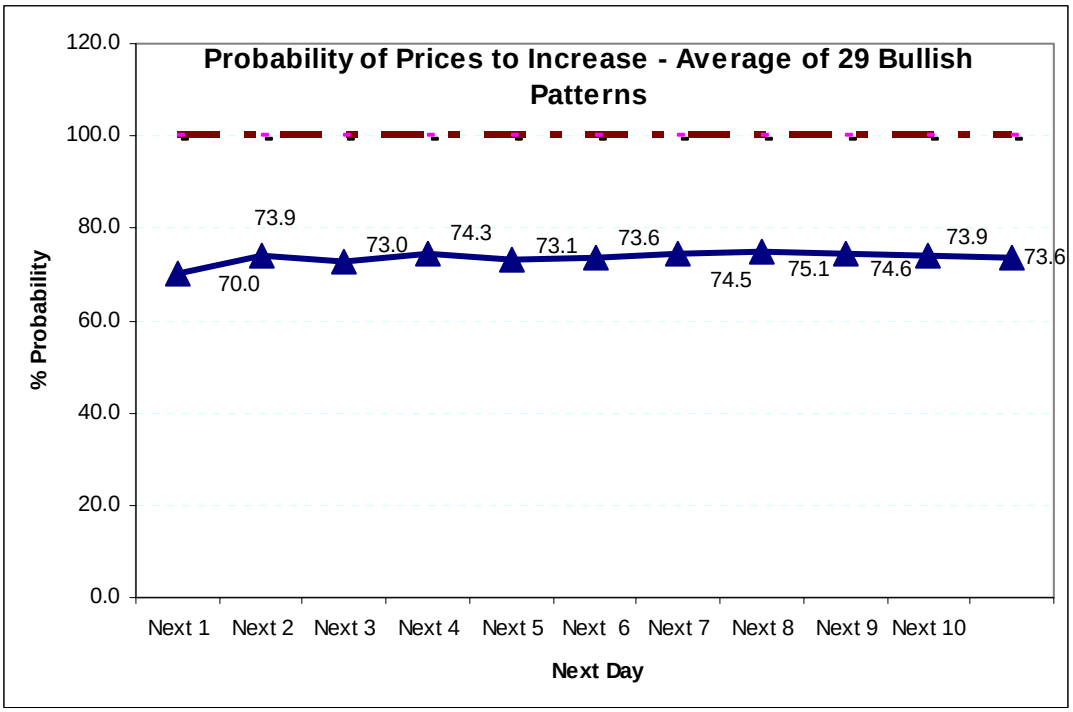


Figure 25. Average Probabilities of Stock Price to Increase

4. Strong Bearish Continuation Patterns

Patterns depicting continuation of a strong downtrend for the next 10 days can be characterized as strong bullish patterns because they depict a high possibility that the prices will decrease during the following days. The average of possibilities of patterns is 70.4%, while the number of different patterns is 14. The next table shows the possibility of the stock price increasing during the next 10 successive days.

FREQ	Pattern of Four Candlesticks	Next 1	Next 2	Next 3	Next 4	Next 5	Next 6	Next 7	Next 8	Next 9	Next 10
46	11001000001000010000000110101011	60.9	67.4	67.4	67.4	69.6	63.0	67.4	67.4	60.9	63.0
38	10000110110000010000101100011011	68.4	60.5	68.4	68.4	73.7	65.8	68.4	60.5	68.4	60.5
26	10110110111000010000101110111011	61.5	65.4	76.9	69.2	76.9	80.8	80.8	76.9	73.1	73.1
26	00000000001001000000010010100100	65.4	76.9	69.2	61.5	69.2	61.5	61.5	65.4	61.5	65.4
24	00111001101000010000010010111011	70.8	75.0	66.7	75.0	66.7	62.5	70.8	70.8	70.8	62.5
23	10000000001000001001001110110011	60.9	69.6	60.9	69.6	78.3	60.9	60.9	65.2	73.9	78.3
21	00000110011011010000101010111011	71.4	76.2	85.7	76.2	76.2	66.7	71.4	71.4	71.4	71.4
21	10000010111000010000001110111011	81.0	66.7	66.7	71.4	66.7	61.9	61.9	76.2	71.4	61.9
18	11001100001001010000101110111011	61.1	83.3	77.8	72.2	88.9	66.7	72.2	66.7	66.7	61.1
16	01001000001000010011010010111011	81.3	68.8	75.0	81.3	75.0	81.3	87.5	87.5	68.8	68.8
16	01001100001001010000100110111011	81.3	68.8	68.8	62.5	68.8	68.8	75.0	75.0	68.8	75.0
16	00010010011000010000010010111011	68.8	62.5	68.8	68.8	75.0	81.3	75.0	75.0	75.0	68.8
15	10111010010000000000010001000100	66.7	66.7	73.3	73.3	80.0	80.0	73.3	73.3	66.7	73.3
15	10000100000000010001101100101011	73.3	80.0	66.7	66.7	66.7	66.7	66.7	73.3	66.7	73.3

Table 8. Strong Bearish Continuation Patterns

The average of probabilities of all the above patterns per day is displayed in the next figure:

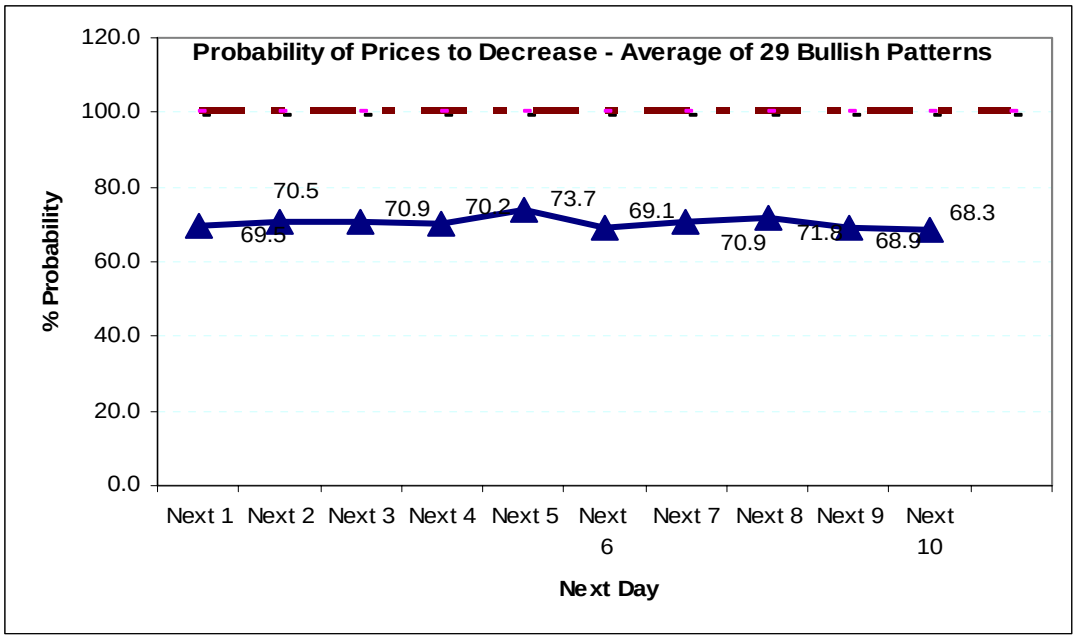


Figure 26. Average Probabilities of Stock Price to Decrease

5. Reverse Bullish Patterns

Patterns depict a strong bullish market for the next two days. After the second day, the probability of stock prices increasing diminishes and the probability becomes less than the probability of prices decreasing in the last 8-10 days. The next table shows the best 10 patterns that have been extracted.

FREQ	Pattern of Four Candlesticks	Next 1	Next 2	Next 3	Next 4	Next 5	Next 6	Next 7	Next 8	Next 9	Next 10
21	10000100001000000010101110110100	76.2	76.2	66.7	57.1	52.4	57.1	57.1	47.6	47.6	47.6
19	00000100000000011001101100101010	73.7	57.9	42.1	26.3	31.6	26.3	31.6	31.6	31.6	42.1
15	10000000000000010000000101000100	73.3	60.0	40.0	53.3	53.3	46.7	53.3	46.7	33.3	33.3
35	10000100000000010110101100111100	71.4	60.0	60.0	48.6	51.4	54.3	48.6	48.6	42.9	40.0
21	10000110011000000111101110110010	71.4	71.4	38.1	42.9	42.9	38.1	42.9	28.6	28.6	28.6
17	10000000000101100000001001000001	70.6	52.9	41.2	52.9	58.8	64.7	52.9	52.9	58.8	35.3
21	10000110011000000111101110110010	71.4	71.4	38.1	42.9	42.9	38.1	42.9	28.6	28.6	28.6
16	00000101111011110000101010111011	75.0	62.5	50.0	43.8	43.8	56.3	56.3	50.0	56.3	43.8
16	00000110011100100000101010110001	75.0	81.3	68.8	68.8	50.0	50.0	50.0	56.3	43.8	43.8
17	10000101101000000000101110110111	52.9	82.4	70.6	52.9	52.9	52.9	47.1	47.1	35.3	29.4

Table 9. Reverse Bullish Patterns After 2 Days

These patterns are significant because they warn that an exit from the market two days earlier than the market reverse is bearish. The average of probabilities of all the above patterns per day is displayed in the next figure:

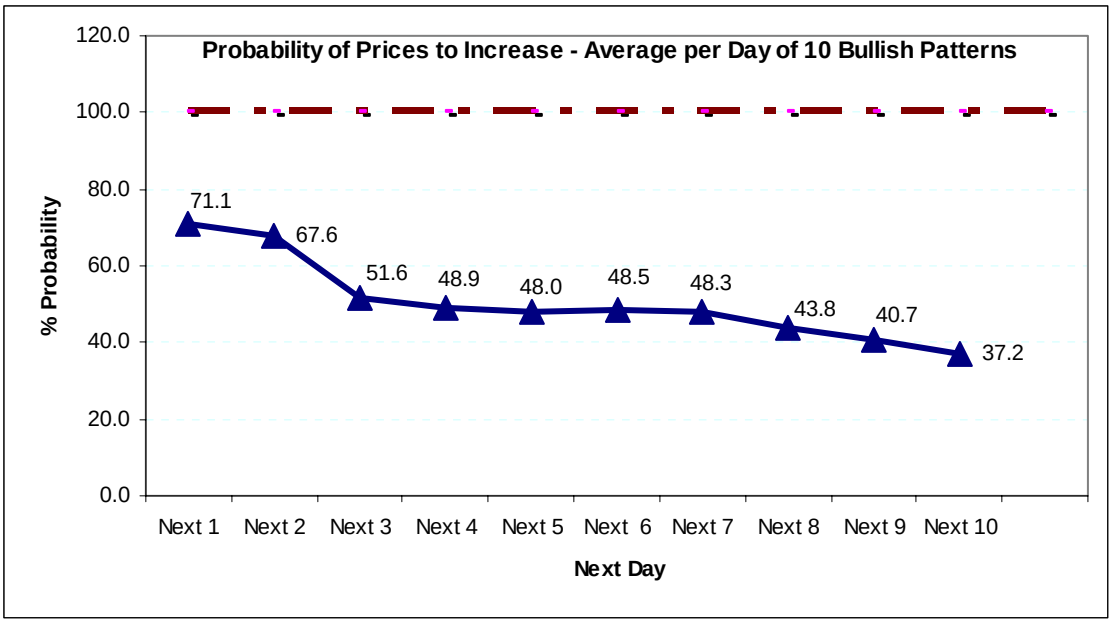


Figure 27. Average Probabilities of Stock Price to Increase

6. Reverse Bearish Patterns

However, patterns depict a strong bearish market in the next 1-2 days. After the second day, the probability of stock prices decreasing diminishes, and becomes less possible than the prices increasing after 7-10 days. The next table shows the best 19 patterns which have been extracted.

FREQ	Pattern of Four Candlesticks	Next 1	Next 2	Next 3	Next 4	Next 5	Next 6	Next 7	Next 8	Next 9	Next 10
20	10000010010001100000001001000100	80.0	65.0	45.0	45.0	45.0	55.0	40.0	35.0	45.0	40.0
15	10000000001100100000001010100001	80.0	60.0	60.0	60.0	53.3	53.3	40.0	40.0	33.3	26.7
19	10000101101000001011101110111011	79.0	47.4	47.4	47.4	52.6	42.1	36.8	42.1	36.8	26.3
16	00000000101000010110010010111011	75.0	56.3	50.0	37.5	43.8	50.0	43.8	43.8	43.8	43.8
19	11011100000100100000101100100100	73.7	57.9	42.1	36.8	36.8	36.8	42.1	36.8	42.1	42.1
16	00000000001001111001010010101011	75.0	50.0	50.0	43.8	43.8	50.0	50.0	31.3	37.5	31.3
15	00000100001000000001101010110011	73.3	33.3	46.7	33.3	40.0	46.7	40.0	46.7	40.0	33.3
27	00111000000000010000000101001001	70.4	51.9	59.3	59.3	55.6	48.2	40.7	37.0	44.4	37.0
17	01011100001000010111101110111011	70.6	64.7	64.7	58.8	52.9	47.1	58.8	41.2	52.9	41.2
17	00111100000000010000101100111100	70.6	58.8	35.3	35.3	41.2	41.2	29.4	35.3	23.5	35.3
17	10000100000101100111101110110100	70.6	52.9	52.9	47.1	47.1	41.2	29.4	35.3	35.3	41.2
17	00000001100011110000010001001011	70.6	47.1	47.1	35.3	35.3	29.4	23.5	35.3	41.2	35.3
17	00111100001000010010101110111011	70.6	41.2	47.1	29.4	41.2	64.7	41.2	41.2	41.2	41.2
24	10000010110000010000101101001010	70.8	50.0	41.7	41.7	45.8	37.5	37.5	37.5	33.3	33.3
18	10000000000101100000001101000001	72.2	55.6	33.3	44.4	22.2	38.9	38.9	27.8	27.8	22.2
18	10110110011000000000101110110100	72.2	61.1	61.1	61.1	66.7	55.6	55.6	50.0	38.9	33.3
15	00000000001001011001010010101011	73.3	66.7	40.0	46.7	33.3	46.7	33.3	33.3	33.3	26.7
19	01001100001000001011101110110010	73.7	68.4	52.6	52.6	52.6	42.1	52.6	47.4	42.1	36.8
16	10000100000001100111101100100100	75.0	81.3	56.3	37.5	50.0	50.0	50.0	56.3	50.0	37.5

Table 10. Reverse Bearish Patterns After 1-2 Days

These patterns warn that the market should be entered two days before the market reverses and becomes bullish. The average of probabilities of all the above patterns per day is displayed in the next figure:

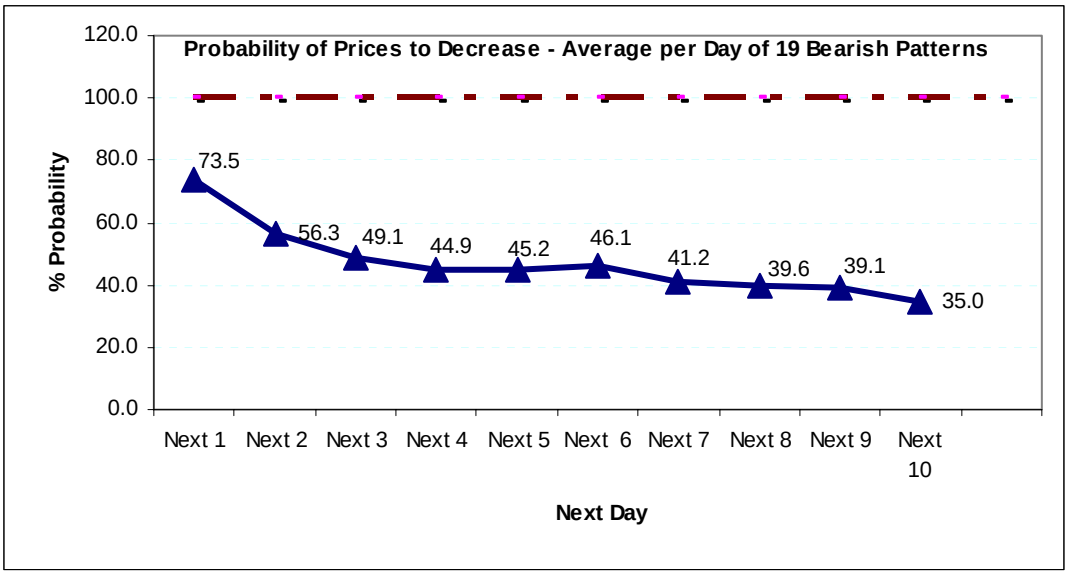


Figure 28. Average Probabilities of Stock Price to Decrease

C. EXPLOITING THE RESULTS

The processes of obtaining the results reveal hidden patterns beyond the popular candlesticks that can assist investment decisions. Reverse patterns that are statistically related to a high possibility of prices increasing or decreasing during the following days are extracted. The advantage of discovered patterns is their successful rate of prediction of the future direction of stock prices, sometimes 10 days ahead. The disadvantage is that rarely they appear which means that they cannot be used daily.

At the moment, it seems these patterns can be used to produce useful alerts during trading. They can produce signals before a reversal begins to occur; this is very useful when deciding when to exit the market before losses occur. It was also discovered that continuation of bullish or bearish patterns assist in similar ways.

IV. RELATIONSHIPS BETWEEN TECHNICAL AND FUNDUMENTAL ANALYSIS – STRATEGIES

A. SETUP STRATEGIES FOR FUNDAMENTAL ANALYSIS

1. Introduction

Before developing investment strategies, it should be made clear the relationship between fundamental data and stock prices. Any relationship between fundamental and technical analysis should also be clarified. It is difficult to select stocks and categorize them. What software tools are available for help? Can it be clearly be distinguished which stock is financially better than others?

Taking the above into consideration, the following steps should be followed:

- Select stocks based on fundamental analysis. Technical analysis should be applied after this is completed.
- Divide firms (stocks) into two categories: large capitalization stocks (market value greater than $1.3 billion) and small capitalization stocks (market value less than $500 million).
- Apply three fundamental filters for each category (large and small capitalization companies) depending on their financial performance: companies with high performance (above average industry), companies with middle performance (about average industry), and companies with low performance (below average industry). These boundaries should be clearly distinguished, so that each stock is without a doubt in the correct category.
- Use Zack's Stock Screener software because its screening criteria contains comparisons that use the average and median of the industry in which the current stock belongs.

- After filtering stocks according to specific criteria, apply technical analysis. Then process results using statistical analysis.

2. Screening Criteria

Stocks are categorized according to their Market Value and financial performance. As a result, six filters were developed using the program "Zacks Research Wizard 4.0." Most filters make comparisons using the median of the relevant sector instead of the mean average. Median is generally better at representing population because it is less sensitive to extremely low or high values. The filters and their results are presented below.

a. Large Capitalization Stocks – High Performance

These are the criteria used to find the best stocks with large capitalization:

• *Market Value*		
	>	*1.3 billion*
• *5 Year Historical EPS Growth %*		
	>	*1. 4 * (Median Value of relevant Sector)*
• *Percentage Change of (EPS current year) / (EPS last year)*		
	>	*1.4 * (Median Value of relevant Sector).*
• *5 Year Historical Sales Growth %*		
	>	*1. 4 * (Median Value of relevant Sector)*
• *Sales Growth between current and last year*		
	>	*1.4 * (Median Value of relevant Sector)*
• *Net Income Growth between current and last year*		
	>	*1.4 * (Median Value of relevant Sector)*
• *Return on Equity (ROE) last 12 months*		

	>	*1.4 * (Median Value of relevant Sector)*
• *Recent Net income reported ($mil)*		
	>	*$ 950 millions*

Table 11. Large Capitalization Stocks – High Performance

The results of running above the filter are displayed below:

Company	Ticker	Market Cap ($mil)	5 Yr Hist EPS Gr	Anl EPS this Yr/ EPS last Yr	5 yr Hist Sales Gr	Anl Sls this Yr/ Sls last Yr	ROE	12 Mo Net Incm Rept ($mil)
Apple Inc	AAPL	$161,230	136.73	73.13	42.02	24.29	27.7	$4,348
Coach Inc	COH	$12,032	39.5	33.07	27.35	23.73	41.91	$730
Dish Network	DISH	$13,632	49.64	23.36	18.39	12.93	233.35	$756
Genentech Inc	DNA	$72,179	47.29	29.61	37.95	26.28	25.75	$2,854
Emc Corp Mass	EMC	$33,541	46.34	33.33	19.98	18.6	13.23	$1,622
Freept Mc Cop	FCX	$43,720	81.67	46.81	62.06	192.56	29.19	$3,543
Gilead Sciences	GILD	$49,367	52.71	25.84	49.88	39.78	55.59	$1,704
Google Inc-Cl A	GOOG	$179,629	62.43	35.89	72.53	56.47	20.56	$4,509
Garmin Ltd	GRMN	$9,133	43.67	65.94	49.64	79.27	38.91	$863
Goldman Sachs	GS	$74,146	43.03	25.6	39.24	26.84	26.82	$9,913
Infosys Tec-Adr	INFY	$24,544	40.61	34.67	41.19	35.15	32.67	$1,155
Mastercard Inc	MA	$37,615	32.63	69.14	15.69	22.29	29.51	$1,318
Nvidia Corp	NVDA	$12,529	69.77	70.87	19.39	33.53	33.76	$842
Precision Castp	PCP	$17,297	39.85	58.12	30.35	27.81	27.6	$987
Potash Sask	POT	$62,436	83.23	75.87	18.78	38.96	26.68	$1,472
Public Storage	PSA	$14,708	12.18	39.22	17.78	31.46	8.71	$910
Research In Mot	RIMM	$74,798	81.42	103.6	75.59	97.87	39.12	$1,294
Turkcell Il-Adr	TKC	$15,708	46.71	54.55	27	34.64	26.13	$1,350
Vimpel-Comm-Adr	VIP	$34,169	45.13	80.45	54.48	47.26	31.35	$1,463
Xto Energy Inc	XTO	$33,038	46.5	8.13	49.15	20.48	21.73	$1,773
Average		**$48,773**	**$55**	**$49**	**$38**	**$45**	**$40**	**$2,170**

Table 12. Stocks: Large Capitalization with High Financial Performance

b. Large Capitalization Stocks – Middle Performance

The following criteria are used to find the large capitalization stocks with middle performance (about the median of the sector):

• *Market Value*		
	>	*1.3 billion*
• *Percentage Change of (EPS current year) / (EPS last year)*		
	<=	*1.5 * (Median Value of relevant Sector) and*
	>	*0.5 * (Median Value of relevant Sector)*
• *Sales Growth between current and last year*		
	<=	*1.5 * (Median Value of relevant Sector) and*
	>	*0.5 * (Median Value of relevant Sector)*
• *Net Income Growth between current and last year*		
	<=	*1.5 * (Median Value of relevant Sector) and*
	>	*0.5 * (Median Value of relevant Sector)*
• *Return on Equity (ROE) last 12 months*		
	<=	*1.5 * (Median Value of relevant Sector) and*
	>	*0.5 * (Median Value of relevant Sector)*

Table 13. Large Capitalization Stocks – Middle Performance

The results of running above the filter are displayed below:

Company	Ticker	Market Cap ($mil)	Anl EPS this Yr/ EPS last Yr	Anl Sls this Yr/ Sls last Yr	Anl Net Incm this Yr/ Net Incm last Yr	ROE	12 Mo Net Incm Rept ($mil)
Ameren Corp	AEE	$9,583	11.3	9.68	12.98	10.38	$644
Amer Elec Pwr	AEP	$17,594	8.3	6.35	8.68	13.34	$1,391
Allete Inc	ALE	$1,298	11.55	9.73	14.66	11.68	$85
Church & Dwight	CHD	$3,568	9.74	14.15	21.67	17.04	$180
Columbia Sports	COLM	$1,447	17.86	5.31	17.43	14.28	$138
Curtiss Wright	CW	$2,141	23.4	24.18	29.49	12.05	$107
Danaher Corp	DHR	$24,531	18.21	14.9	22.09	15.26	$1,392
Dover Corp	DOV	$9,931	9.52	10.57	17.68	16.88	$679
Firstenergy Cp	FE	$23,164	9.09	11.3	4.39	14.86	$1,295
Genl Electric	GE	$322,115	10	5.72	6.62	18.87	$21,959
Lincoln Electrc	LECO	$3,352	17.34	15.66	15.85	19.65	$208
L-3 Comm Hldgs	LLL	$13,180	23.55	11.89	43.72	13.39	$786
Moog Inc A	MOG.A	$1,798	18.78	19.26	24.08	12.16	$109
Procter & Gambl	PG	$200,684	15.15	12.1	19.07	16.92	$11,327
Pentair Corp	PNR	$3,636	14.92	7.74	14.8	11.7	$213
Southn Company	SO	$27,751	4.67	6.95	10.24	14.29	$1,754
Sonoco Products	SON	$3,228	11.74	10.48	9.78	17.24	$174
Sensient Tech	SXT	$1,426	15.39	7.83	17.1	10.09	$81
Symantec Corp	SYMC	$16,920	19.1	12.98	14.71	8.48	$464
Wisc Energy Cp	WEC	$5,614	10.08	6.04	6.07	11.66	$358
Average		$34,648	$14	$11	$17	$14	$2,167

Table 14. Stocks: Large Capitalization with Middle Financial Performance

c. Large Capitalization Stocks – Low Performance

The following criteria are used to find the large capitalization stocks with low performance (below median of the sector):

• *Market Value*		
	>	*1.3 billion*
• *Percentage Change of (EPS current year) / (EPS last year)*		
	<	*0.5 * (Median Value of relevant Sector).*

• *Sales Growth between current and last year*		
	<	*0.5 * (Median Value of relevant Sector)*
• *Net Income Growth between current and last year*		
	<	*0.5 * (Median Value of relevant Sector)*
• *Return on Equity (ROE) last 12 months*		
	<	*0.5 * (Median Value of relevant Sector)*
• *Net Income Reported ($mil)*		
	<	*0.3 * (Median Value of relevant Sector)*

Table 15. Large Capitalization Stocks – Low Performance

The results of running above the filter are displayed below:

Company	Ticker	Market Cap ($mil)	Anl EPS this Yr/ EPS last Yr	Anl Sls this Yr/ Sls last Yr	Anl Net Incm this Yr/ Net Incm last Yr	Return on Equity	Net Incm Rept ($mil)	Sales ($mil)
Popular Inc	BPOP	$3,314	-35.48	-1.33	-118.03	2.93	($64)	$3,822
Countrywide	CFC	$2,765	-130.47	-46.91	-126.3	-11.22	($704)	$6,061
Cit Group Inc	CIT	$2,222	-39.38	-74.95	-107.74	2.19	($81)	$1,735
Centex Corp	CTX	$2,614	-100.98	-31.12	-1090.27	-58.62	($2,657)	$8,276
D R Horton Inc	DHI	$4,674	-123.25	-24.95	-157.77	-1.17	($713)	$11,297
Delta Pete	DPTR	$2,398	-570.97	-7.05	-34830.2	-11.68	($149)	$164
Fannie Mae	FNM	$27,206	-171.78	-10.9	-150.51	-6.63	($2,050)	$43,355
Freddie Mac	FRE	$16,249	-289.09	-2.04	-239.94	-22.03	($3,094)	$43,104
Iac/Interactiv	IACI	$5,988	-14.6	1.53	-174.79	4.26	($144)	$6,373
Kb Home	KBH	$2,126	-236.97	-41.69	-292.68	-50.58	($929)	$6,417
Liberty Glbl-A	LBTYA	$11,984	-16.67	-94.13	-159.84	-4.75	($423)	$381
Lennar Corp -A	LEN	$2,960	-91.6	-37.38	-426.86	-15.46	($1,941)	$10,187
Mbia Inc	MBI	$2,227	-73.84	-126.64	-334.59	3.2	($1,922)	($393)
Motorola Inc	MOT	$22,007	-81.96	-14.59	-101.34	2.63	($49)	$36,622
Nomura Hldg	NMR	$34,109	-45.46	-17.71	-140.82	-3.14	($611)	$14,343
Novell Inc	NOVL	$2,239	-118.18	-3.6	-338.39	1	($44)	$932
Pulte Homes	PHM	$3,353	-217.23	-35.11	-428.12	-23.93	($2,256)	$9,263

Rambus Inc	RMBS	$2,360	-84.62	-7.88	-100.29	-8.5	($28)	$180
Vertex Pharm	VRTX	$3,736	-64.64	-8.02	-89.12	-122.42	($391)	$199
Wash Mutual	WM	$9,062	-48.67	-2.87	-101.88	-1.67	($67)	$25,531
Average		$8,180	($128)	($29)	($1,975)	($16)	($916)	$11,392

Table 16. Stocks: Large Capitalization with Low Financial Performance

d. Small Capitalization Stocks – High Performance

The following are the criteria used to find the best stocks with small capitalization:

• *Market Value*		
	<	*500 million*
• *Percentage Change of (EPS current year) / (EPS last year)*		
	>	*1.5 * (Median Value of relevant Sector).*
• *Sales Growth between current and last year*		
	>	*1.5 * (Median Value of relevant Sector)*
• *Net Income Growth between current and last year*		
	>	*1.5 * (Median Value of relevant Sector)*
• *Return on Equity (ROE) last 12 months*		
	>	*1.5 * (Median Value of relevant Sector)*
• *Recent Net income reported ($mil)*		

	>	*2.0 * (Median Value of relevant Sector)*
• *Recent Net income reported ($mil)*		
	>	*$ 10 millions*
• *Current Ratio – Most Recent*		
	>	*(Median Value of relevant Sector)*

Table 17. Small Capitalization Stocks – High Performance

The results of running above filter are displayed below:

Company	Ticker	Market Cap ($mil)	Anl EPS this Yr/ EPS last Yr	Anl Net Incm this Yr/ Net Incm last Yr	ROE	Current Ratio	12 Mo Net Incm Rept ($mil)	Sales ($mil)
Asta Funding	ASFI	$133	16.61	14.21	24.15	95.7	$54	$141
Azz Inc	AZZ	$345	23.5	28.15	20.68	2.41	$28	$320
Comtech Grp	COGO	$498	23.4	32.3	12.92	4.31	$22	$228
Capital Trust-A	CT	$463	40.29	56.05	19.54	11.96	$84	$265
Darwin Profes	DR	$436	98.95	102.01	13.88	1.5	$42	$203
Global Partners	GLP	$143	34.71	40.5	22.9	1.22	$23	$6,758
Jos A Bank Clth	JOSB	$454	15.25	16.06	21.34	2.48	$50	$604
Jinpan Intl Ltd	JST	$327	82.14	119.57	26.05	2.53	$16	$120
Nighthawk Radio	NHWK	$235	28.36	151.73	22.01	3.74	$11	$152
Omnicell Inc	OMCL	$475	84.21	317.86	10.15	3.58	$43	$213
Perficient Inc	PRFT	$332	39.54	69.77	12.62	2.81	$16	$218
Pain Therapeut	PTIE	$352	214.29	228.48	20.96	9.95	$10	$66
Ramtron Intl Cp	RMTR	$110	350	2097.78	11.61	3.65	$11	$51
Smart Modular	SMOD	$371	23.53	73.13	21.32	3.31	$50	$828
Soapstone Ntwrk	SOAP	$101	182.99	652.05	64.62	12.5	$53	$124
Spectrum Contrl	SPEC	$104	84.09	89.78	10.93	4.37	$11	$137
Tradestation Gp	TRAD	$424	16.42	14.06	25.56	1.18	$35	$152
Trimeris Inc	TRMS	$144	154.55	271.55	32.9	11.45	$22	$49
Univl Insur Hld	UVE	$138	222.73	214.32	106.2	1.52	$54	$189
Vasco Data Sec	VDSI	$419	66.67	66.61	30.3	3.2	$21	$120
Average		**$300**	**$90**	**$233**	**$27**	**$9**	**$33**	**$547**

Table 18. Stocks: Small Capitalization and High financial performance

e. Small Capitalization Stocks – Middle Performance

The following are the criteria used to find small capitalization stocks with middle performance:

• *Market Value*		
	<	*500 million*
• *Percentage Change of (EPS current year) / (EPS last year)*		
	<=	*1.5 * (Median Value of relevant Sector) and*
	>	*0.4 * (Median Value of relevant Sector).*
• *Sales Growth between current and last year*		
	<=	*1.5 * (Median Value of relevant Sector) and*
	>	*0.4 * (Median Value of relevant Sector).*
• *Return on Equity (ROE) last 12 months*		
	<=	*1.5 * (Median Value of relevant Sector) and*
	>	*0.4 * (Median Value of relevant Sector).*
• *Net Income Growth between current and last year*		
	<=	*1.5 * (Median Value of relevant Sector) and*
	>	*0.4 * (Median Value of relevant Sector).*
• *Recent Net income reported ($mil)*		
	>=	*$ 8 millions*
• *Current Ratio – Most Recent*		
	>	*0.75*

Table 19. Small Capitalization Stocks – Middle Performance

The results of running above the filter are displayed below:

Company	Ticker	Market Cap ($mil)	Anl EPS this Yr/ EPS last Yr	Anl Sls this Yr/ Sls last Yr	Anl Net Incm this Yr/ Net Incm last Yr	ROE	Current Ratio	12 Mo Net Incm Rept ($mil)	Sales ($mil)
Build-A-Bear Wk	BBW	$213	-15.97	8.53	-23.7	12.62	1.44	$21	$474
Baldwin Tech A	BLD	$36	20	12.32	6.24	12.28	1.5	$7	$201
Colony Bankcorp	CBAN	$92	-14.18	8.15	-15.86	9.97	0.97	$8	$98
Columbia Bcp-Or	CBBO	$109	-8.39	12.26	-8.18	12.25	1.02	$12	$90
Center Finl Cp	CLFC	$164	-16.56	7.59	-16.1	12.76	1.13	$20	$158
Crawford & Co-A	CRD.A	$213	-10	16.76	7.33	5.73	1.31	$16	$1,051
Crawford & Co B	CRD.B	$253	-10	16.76	7.33	5.74	1.31	$16	$1,051
Citizens&Nrthrn	CZNC	$166	-15.95	10.84	-13.02	7.9	0.87	$11	$81
Ducommun Inc	DCO	$328	35.25	15.13	37.3	10.04	2.17	$21	$367
First Finl Svcs	FFKY	$104	-16.24	11.66	-9.47	12.22	1.08	$9	$69
German Amer	GABC	$139	-8.6	11.37	-8.02	11.41	1.03	$11	$88
Ibt Bcp Irwn Pa	IRW	$181	-5	7.36	-7.1	9.73	0.76	$8	$51
Pab Bankshares	PABK	$127	-19.86	9.31	-21.49	9.3	0.94	$9	$91
Perry Ellis Int	PERY	$348	13.92	4.1	25.76	10.65	3.44	$28	$864
Stratasys Inc	SSYS	$447	22.22	8.13	28.32	12.44	3.39	$15	$112
Stellarone Corp	STEL	$177	-12.78	2.69	-12.78	8.27	0.98	$15	$116
Argon St Inc	STST	$435	-4.6	9.03	-24.19	6.46	2.56	$15	$282
Standex Intl Co	SXI	$241	-23.35	5.3	-8.21	7.4	1.67	$16	$621
Univl Truckload	UACL	$352	-14.62	6.04	-15.1	12.35	2.34	$18	$680
Weyco Group	WEYS	$313	5.53	5.23	4.81	14.21	4.72	$22	$233
Average		**$222**	**($5)**	**$9**	**($3)**	**$10**	**$2**	**$15**	**$339**

Table 20. Stocks: Small Capitalization with Middle Financial Performance

f. Small Capitalization Stocks – Low Performance

The following are the criteria used to find small capitalization stocks with low performance:

• *Market Value*		
	<	*500 million*
• *Percentage Change of (EPS current year) / (EPS last year)*		
	<	*0.2 * (Median Value of relevant Sector).*

• *Sales Growth between current and last year*		
	<	*0.2 * (Median Value of relevant Sector)*
• *Net Income Growth between current and last year*		
	<	*0.2 * (Median Value of relevant Sector)*
• *Net Income Growth between last and previous year*		
	<	*0.2 * (Median Value of relevant Sector)*
• *Return on Equity (ROE) last 12 months*		
	<	*0.2 * (Median Value of relevant Sector)*
• *Recent Net income reported ($mil)*		
	<	*0.2 * (Median Value of relevant Sector)*
• *Recent Net income reported ($mil)*		
	>	*$ 10 millions*
• *Current Ratio – Most Recent*		
	>	*(Median Value of relevant Sector)*

Table 21. Small Capitalization Stocks – Low Performance

The results of running above the filter are displayed below:

Company	Ticker	Market Cap ($mil)	Anl EPS this Yr/ EPS last Yr	Anl Net Incm this Yr/ Net Incm last Yr	Anl Net Incm last Yr/ Net Incm prior Yr	ROE	Current Ratio	12 Mo Net Incm Rept ($mil)
Adstar Inc	ADST	$2	0	-138.13	-27.52	-76.13	0.72	($3)
Aspyra Inc	APY	$7	-22.22	-17.93	-42.69	-41.32	0.32	($5)
Apogee Tech Inc	ATCS	$8	-204.17	-7.74	-200.68	-311.75	0.36	($3)
Blue Holdings	BLUE	$15	-16.67	-17.65	-192.61	-290.27	0.85	($6)
Bimini Cap Mgmt	BMNM	$8	-238.79	-399.9	-304.04	-290.24	0.06	($248)
Minrad Intl Inc	BUF	$89	-95	-184.7	-29.92	-74.32	0.89	($19)
Carrington Labs	CARN	$4	-38.89	-28.42	-42.59	-2073.38	0.67	($10)
Cytogenix Inc	CYGX	$7	0	-53.06	-15.86	-1887.22	0.23	($6)
Energy Partners	EPL	$461	-112.4	-58.63	-168.96	-2.5	0.52	($81)
Focus Enhance	FCSE	$41	-46.67	-9.05	-3.65	-351.97	0.85	($17)
Gasco Egy Inc	GSX	$331	-33.33	-87.01	-185933	-22.25	0.58	($109)
Jupitermedia Cp	JUPM	$78	-128.57	-727.06	-83.26	0.63	1.05	($78)
Max &Ermas Rest	MAXE	$10	-1900	-169.47	0	-17.54	0.45	($5)
Meritage Homes	MTH	$453	-232.33	-228.18	-11.86	-43.14	0.39	($349)
Nymox Pharmactl	NYMX	$133	0	-8.09	-36.51	-244.91	0.34	($5)
Paincare Hldgs	PRZ	$2	-550	-277	-396.81	-262.61	1.07	($106)
Sten Corp	STEN	$9	-566.67	-266.67	-287.5	-46.1	1.28	($3)
Sri Surgicl Exp	STRC	$26	-61.29	-63.59	-600	-6.97	1.33	($4)
Top Ships Inc	TOPS	$170	-224.33	-424.11	-77.96	-16.54	0.56	($49)
Youbet.Com Inc	UBET	$51	-800	-1202.96	-135.68	-35.9	0.66	($28)
Average		$95	($264)	($218)	($9,430)	($305)	0.66	($57)

Table 22. Stocks: Small Capitalization with Low Financial Performance

B. SETUP STRATEGIES FOR TECHNICAL ANALYSIS

1. Introduction

After selecting the six stock categories, the next step is to use technical analysis concerning the development of trading systems for a specific historical period. The preparation includes the following steps:

- Obtain the list of stocks produced from running the screener and download the stock data from Yahoo.com for January 3, 2005 until May 9, 2008.
- Keep the stock data in a custom database.
- Develop the trading systems that will be used.

Then, apply technical analysis so that the maximum profitable results for the period January 3, 2005 until May 9, 2008 are acquired. A problem is created because trading systems depend on the input parameters used by technical indicators and the selected stock. In other words, the performance of a specific trading system may vary from negative (loss) to positive (gain) depending on the value of the input parameters. A specific trading system with specific parameters also performs differently when applied to other stocks.

This phase is critical because any relationship between fundamental and technical analysis is examined. If technical analysis is not applied properly, then results are inaccurate. The methodology that produced the best results was “optimization” of the trading systems and “adaptation”. Optimization finds the input parameters of the technical indicator that produce the most profitable trades for a specific time period. Therefore, each trading system should be optimized for each separate stock.

In order to produce more reliable results, 12 different trading systems were developed. Each trading system is optimized for each stock; the values of the optimized parameters are kept. The number of optimizations which take place is (12 trading systems) x (118 stocks). The next diagram shows the process of optimizing the trading systems for all the stocks.

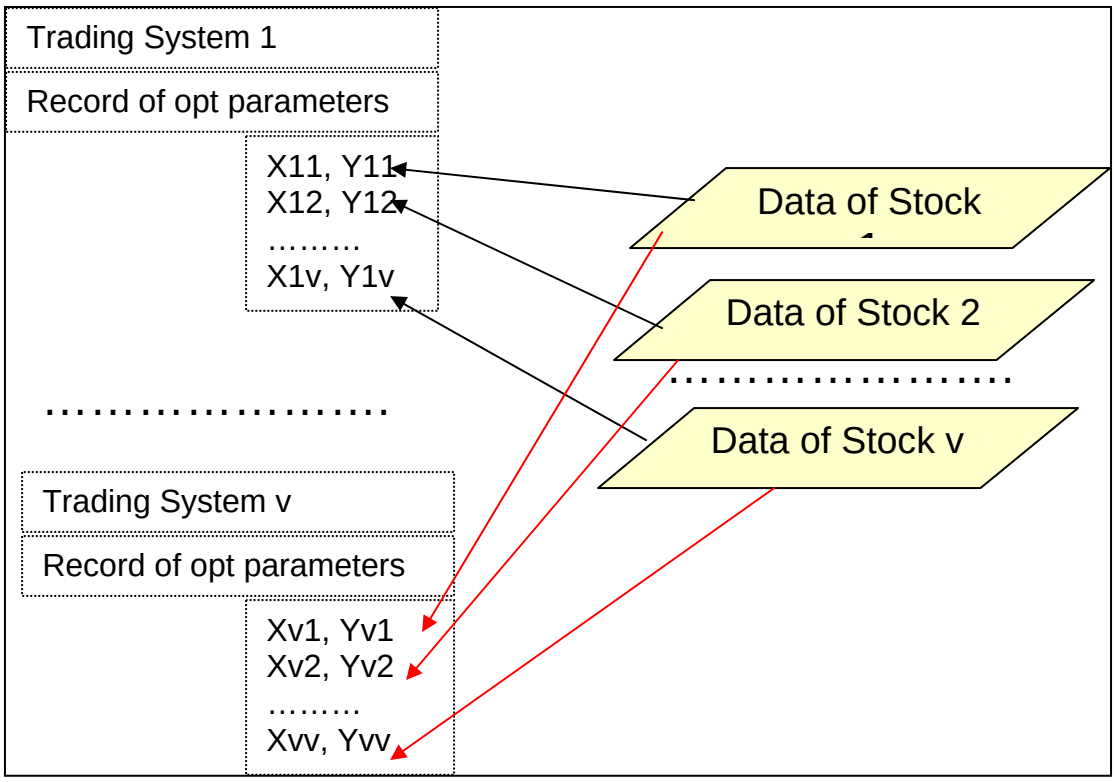


Figure 29. Optimization Process of the Trading Systems

2. Developing Trading Systems

The 12 trading systems that developed are the following:

Simple Moving Average (SMA) Trading System. The SMA is the oldest and most popular indicator used in the stock market. It is the average of stock prices for the most "n" periods. It uses one input parameter, which is the number of time periods (here, the period measures by day). The buy signal is produced when the stock price crosses above its SMA. The optimization of the parameter was examined for a range of 6 to 50 days.

Exponential Moving Average (EMA) Trading System. This system is a weighted moving average (most recent values are weighted higher than the previous values). The buy signal is produced when the stock price crosses above its EMA. The optimization of the parameter was examined during a time range of 6 to 50 days.

Commodity Channel Index (CCI) Trading System. CCI was designed to identify cyclical trends. It measures the difference between a stock price from its statistical mean. The trading system uses three input parameters: one refers to the CCI indicator and the other two refer to the trading signals. The following table is examination of the optimization:

Input Parameter	Buy/Sell Signals	Range of Input Value
CCI: number of days	N/A	Periods: 8 to 25
Constant value x for buy	Buy: CCI > x	x: -150 to -50
Constant value y for sell	Sell: CCI < y	y: 50 to 150

Chaikin A/D Trading System. This system counts the rate of the volume accumulation / distribution of a stock. Three input parameters are used: two measures the Chaikin indicator and the other measures the trading signals. The optimization was examined:

Input Parameters	Buy/Sell Signals	Range of Input Value
Chaikin: number of short days	N/A	Periods: 2 to 5
Chaikin: number of long days	N/A	Periods: 8 to 14
Moving Average (SMA) of Chaikin	Buy: Chaikin > SMA Sell: Chaikin < SMA	Periods: 4 to 10

Chandle Momentum Oscilator (CMO) Trading System[30]. The Chande's Momentum Oscillator function determines the momentum of price data by comparing the size of recent negative price changes to the size of positive price changes. The trading system uses three input parameters: one measures the CMO indicator and the other two measure the trading signals. The optimization was examined:

30 Trading Solutions Website, Trading Solutions Function Documentation, April 2008, http://www.tradingsolutions.com/functions/ChandesMomentumOscillator.html.

Input Parameter	Buy/Sell Signals	Range of Input Value
CMO: number of days	N/A	Periods: 6 to 20
Constant value x for buy	Buy: CMO > x	x: -60 to -40
Constant value y for sell	Sell: CMO < y	y: 40 to 60

Directional Movement Index (DMI) Trading System. The DMI shows if stock is trading or not. It consists of two indicators: a Negative Directional Indicator (-DI) and Positive Directional Indicator (+DI). The buy signal is produced when the +DI rises above the –DI; the sell signal is produced when the +DI falls below the –DI. The trading system uses three input parameters: one measures the DMI, and the other two measure the trading signals. The optimization was examined:

Input Parameter	Buy/Sell Signals	Range of Input Value
+DI, -DI: number of days	N/A	Periods: 6 to 20
Crossover between +DI, -DI	Buy: +DI > -DI	N/A
Crossover between +DI, -DI	Sell: +DI < -DI	N/A

Price Oscillator (PriceOsc) Trading System. PriceOsc is the calculation of the difference between SMA (short period of days) and SMA (long period of days). It depicts the acceleration of prices. The crossover of its moving average produces signals. The trading system uses three input parameters: two measure the Chaikin indicator; the other measures the trading signals. The following is the examination of the optimization:

Input Parameters	Buy/Sell Signals	Range of Input Value
PriceOsc: number of short days	N/A	Periods: 5 to 15
PriceOsc: number of long days	N/A	Periods: 16 to 40
Moving Average (SMA) of PriceOsc	Buy: PriceOsc > SMA Sell: PriceOsc < SMA	Periods: 4 to 10

Rate of Change (ROC) Trading System. The ROC is a calculation of the percentage of the division of the current Close value to the Close value of ‘x’ days ago. It

counts the acceleration of the prices. The trading system uses three input parameters: one measures the ROC indicator;the other two measure the trading signals. The following is the examination of the optimization:

Input Parameter	Buy/Sell Signals	Range of Input Value
ROC: number of days	N/A	Periods: 6 to 20
Constant value x for buy	Buy: ROC > x	x: -20 to 20
Constant value y for sell	Sell: ROC < y	y: -20 to 20

Relative Strength Index (RSI) Trading System. RSI[31] is a technical momentum indicator that compares the magnitude of recent gains to recet losses in an attempt to determine overbought and oversold conditions of an asset. It is calculated using the formula RSI = 100 / (1 +RS), where RS = Average of x days' up closes / Average of x days' down closes. The trading uses three input parameters: one measures the ROC indicator; the other two measure the trading signals. The following is the examination of the optimization:

Input Parameter	Buy/Sell Signals	Range of Input Value
RSI: number of days	N/A	Periods: 10 to 20
Constant value x for buy	Buy: RSI > x	x: 20 to 40
Constant value y for sell	Sell: RSI < y	y: 60 to 80

Relative Volatility Index (RVI) Trading System. RVI[32] is simply the Relative Strength Index (RSI) with the standard deviation over the past ‘x’ days used instead of daily price change. The trading system uses three input parameters: one is refers to the RVI indicator; the other two refer to the trading signals. following is the examination of the optimization:

31 Investopedia Encyclopedia, April 2008, http://www.investopedia.com/terms/r/rsi.asp.

32 Investopedia Encyclopedia, April 2008, http://store.traders.com/-v11-c06-therela-pdf.html.

Input Parameter	Buy/Sell Signals	Range of Input Value
RVI: number of days	N/A	Periods: 8 to 20
Constant value x for buy	Buy: RVI > x	x: 50 to 70
Constant value y for sell	Sell: RVI < y	y: 30 to 50

Stochastic Oscilator (StochOsc) Trading System. StochOsc[33] is a technical momentum indicator that compares a stock's closing price to its price range over a given time period. The trading system uses two input parameters: one refers to the StochOsc indicator; the other refers to the trading signals. The signals are produced by the crossover of its moving average. following is the examination of the optimization:

Input Parameters	Buy/Sell Signals	Range of Input Value
StochOsc: number of days	N/A	Periods: 10 to 20
Moving Average (SMA) of StochOsc	Buy: StochOsc > SMA Sell: StochOsc < SMA	Periods: 2 to 6

C. STATISTICAL PROCESSES - RESULTS

1. Getting the Results

The 12 trading systems above can run for all the stocks selected by a screener. The software tool which runs and optimizes the trading systems for each stock is custom—not commercial. The results for each category of the stocks are depicted in the appendix, followed by the statistical process including Mean, Median, Standard Deviation, Min, Max and Regression Analysis.

33 Investopedia Encyclopedia, April 2008, http://www.investopedia.com/terms/s/stochasticoscillator.asp.

2. Applying Statistical Analysis

a. The Role of Fundamental Analysis in Stock Prices

It is accepted that companies with high financial indicator performance, such as increasing growth in sales, income statements, ROE, etc, also have significant increases in their stock prices when they are traded in the stock market over a long period of time. In other words, stock prices are affected by the financial performance of the firms. Here, companies are separated according to their capitalization (book value), and the effects of financial strengths on their stock price are examined. The next table presents the results of applying statistics.

Effects of Financial Value on % Change in Stock Price					
	Mean	**Median**	**Stdv**	**Min**	**Max**
LARGE CAP - HIGH PERFORMANCE	205.5	182.8	45.2	2.0	628.2
LARGE CAP - MIDDLE PERFORMANCE	38.1	35.1	41.5	-27.3	138.2
LARGE CAP- LOW PERFORMANCE	-38.6	-52.2	42.5	-86.0	57.6
SMALL CAP - HIGH PERFORMANCE	45.5	10.9	140.5	-63.1	564.7
SMALL CAP - MIDDLE PERFORMANCE	-7.0	-19.6	38.0	-69.7	72.5
SMALL CAP - LOW PERFORMANCE	-53.7	-63.7	41.6	-99.0	61.9

Table 23. The effects of financial strength of the firm in its stock price

The next shows the mean of changes of large firms' stock prices according to each firm's financial performance. It seems that there is a relation between fundamental analysis and a share's price in the stock market. Stock prices are a reflection of firms' financial value over a long period. This is a reflection of the mean of the firms belonging to the same category, not to an individual stock's price change.

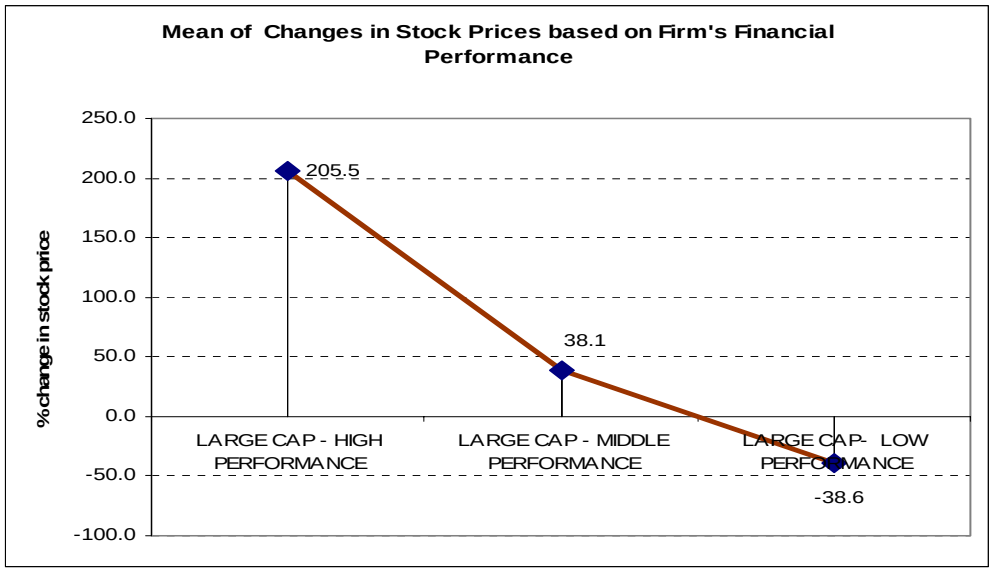


Figure 30. Stock Price Changes / Large Firm's Performance

The next figure represents the mean of changes of small firms' stock prices according their financial performance. Similar to the previous figure, it seems that there is a relationship between fundamental analysis and small firms' share prices in the stock market. The stock prices in a long turn depend on the size (market value) of the firm. Small capitalization firms reflect stock prices less than large firms belonging to the same category.

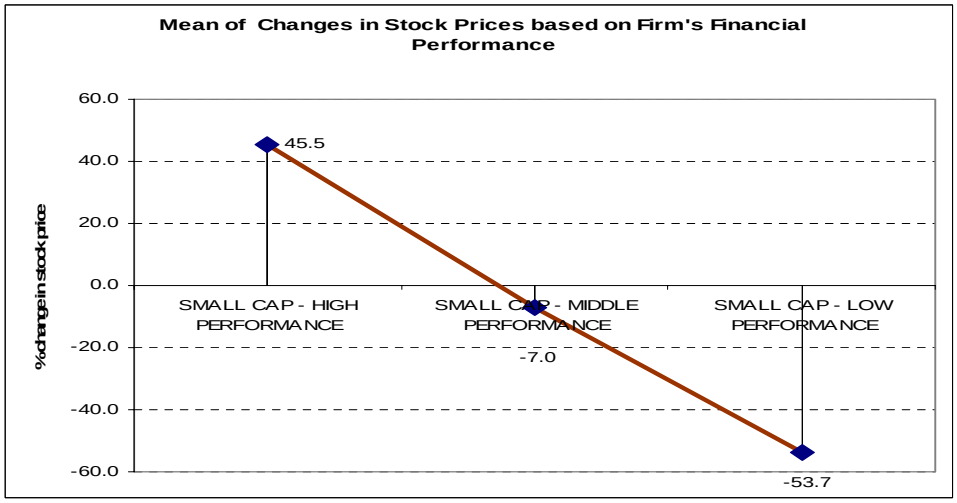


Figure 31. Stock Price Changes / Small Firm's Performance

b. The Worst in Performance Trading Systems.

For each stock we applied 12 trading systems optimized for the best results. To examine if any relationship exists between the six categories of firms, the least profitable trading system was chosen for comparison. The next table represents the statistical results:

% Min Performance of Trading Systems					
	Mean	**Median**	**Stdv**	**Min**	**Max**
LARGE CAP - HIGH PERFORMANCE	88.4	45.6	75.6	-5.9	212.0
LARGE CAP - MIDDLE PERFORMANCE	-3.1	1.9	30.7	-109.2	36.8
LARGE CAP- LOW PERFORMANCE	-19.8	-33.2	37.4	-67.8	62.4
SMALL CAP - HIGH PERFORMANCE	22.0	-5.2	88.6	-54.1	320.3
SMALL CAP - MIDDLE PERFORMANCE	-71.0	-71.4	79.1	-265.4	48.0
SMALL CAP - LOW PERFORMANCE	-74.2	-73.7	64.7	-181.0	42.0

Table 24. The performance of the Worst Trading Systems

The table above shows that the worst trading system depends on the financial performance of the firm. It becomes worse as the financial performance of the firm is decreasing. The performance of the worst trading system also depends on the size (book value) of the firm. As the firm becomes larger, the performance of the worst trading system gets better.

The next figure depicts the average of the worst trading systems performances for large and small capitalized firms. It shows that technical analysis produces better results for large firms.

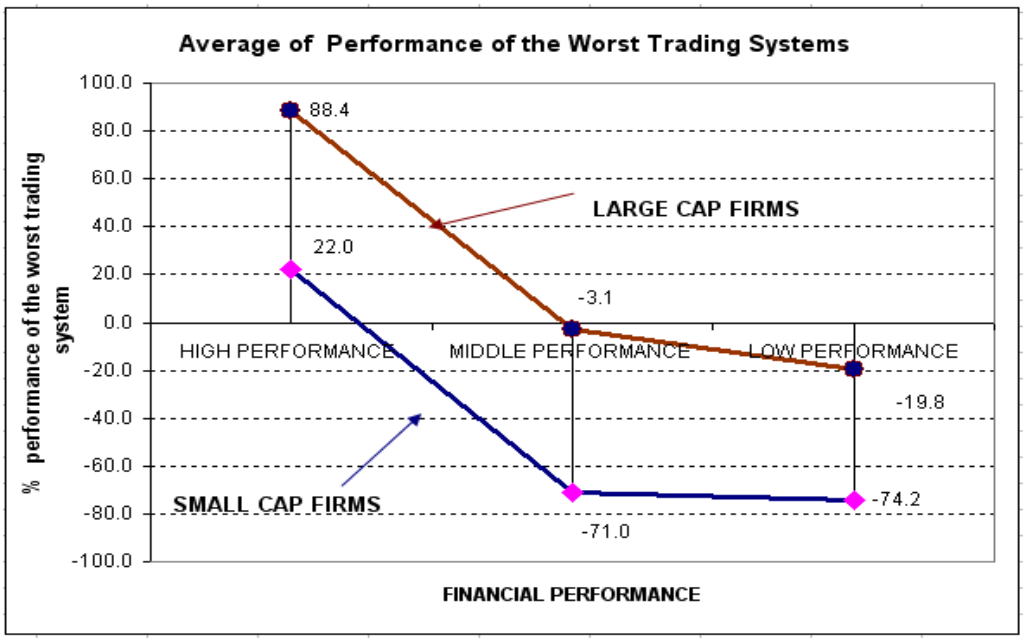


Figure 32. Average Performance of the Worst Trading Systems

c. The Best in Performance Trading Systems

To examine if any relationship between the six categories of companies exists, the best performing trading system was chosen. The next table represents the statistical results:

% Max Performance of Trading Systems					
	Mean	**Median**	**Stdv**	**Min**	**Max**
LARGE CAP - HIGH PERFORMANCE	303.0	246.2	204.8	82.4	746.8
LARGE CAP - MIDDLE PERFORMANCE	75.9	67.2	40.6	34.5	200.8
LARGE CAP- LOW PERFORMANCE	69.0	54.9	47.4	23.8	197.6
SMALL CAP - HIGH PERFORMANCE	182.4	121.4	150.0	55.1	665.0
SMALL CAP - MIDDLE PERFORMANCE	83.6	72.7	39.9	31.3	160.9
SMALL CAP - LOW PERFORMANCE	224.6	90.3	574.8	18.8	2652.6

Table 25. The performance of the Best Trading Systems

The following can be observed from the table above:

- In large capitalization firms, the performance of technical analysis is related to the financial value of the firm. When applied, technical analysis brings results that are more profitable for the firms which are stronger financially.
- In small capitalization firms, technical analysis is related to the financial status only for firms with moderate and high financial performance. For the small firms which are financially unstable, the performance of technical analysis is not related to the firm's financial status. This can be seen by comparing the mean. If there was a relationship, then the firms with low financial performance should have a mean less than 83.6% of the firms performing moderately.
- The standard deviation (Stdv) of small firms with low performance is very high (574.8). This means that the performance of the trading system has various and extreme values relative to the mean.
- Although technical analysis creates better results for small firms with low financial performance, the mean of trading system performances referring to small firms is less than those of large firms with high financial performance.

In the figure below, it can be distinguished that technical analysis has better results in large firms with a high financial performance, and for small firms with a low financial performance, it creates more profitable results.

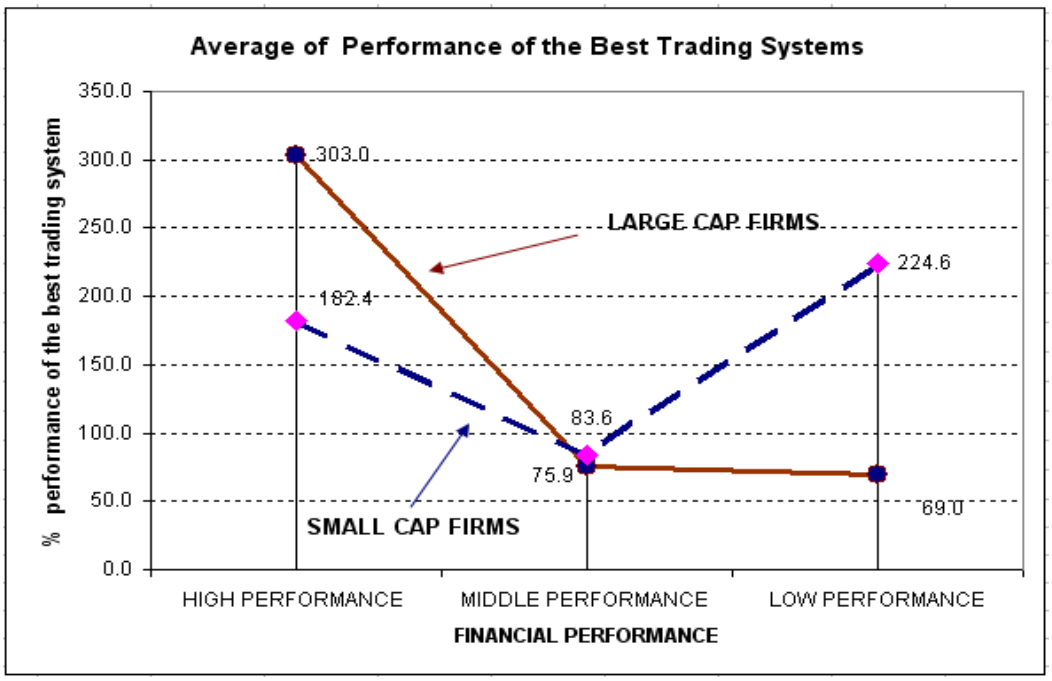


Figure 33. Average Performance of the Best Trading Systems

d. The Performance of Trading Systems and Changes in Stock Price

The next statistical process is the discovery of the relationship between stock price increases over a specific period and the performance of the technical analysis for the same period. The table below presents the mean of stock price changes, the mean of the performance of the trading systems, and the mean of the difference between the change in prices and the performance of the trading systems[34]. Technical analysis contributes positively to firms with low financial performance, independently of the size (large or small capitalization).

34 If the difference is positive it means that the trading system brings greater profitable results than the change in stock price.

	Mean: % Change in Price	Mean: % Trading	Mean: % Difference
LARGE CAP - HIGH PERFORMANCE	205.5	303.0	97.5
LARGE CAP - MIDDLE PERFORMANCE	38.1	75.9	37.8
LARGE CAP- LOW PERFORMANCE	-38.6	69.0	107.6
SMALL CAP - HIGH PERFORMANCE	45.5	182.4	136.8
SMALL CAP - MIDDLE PERFORMANCE	-7.0	83.6	90.7
SMALL CAP - LOW PERFORFORMANCE	-53.7	224.6	278.3

Table 26. Mean: % Changes in Prices, % Trading and Difference of Them

The following table shows the statistical results of the differences between changes in stock prices and the performance of trading systems. The standard deviation for small firms with low financial performance is very high, which means that elements with extreme values over or below the mean exist.

% Technical Performance Above Stock Prices					
	Mean	Median	Stdv	Min	Max
LARGE CAP - HIGH PERFORMANCE	97.5	79.6	61.2	-1.8	256.8
LARGE CAP - MIDDLE PERFORMANCE	37.8	35.8	22.2	11.1	89.0
LARGE CAP- LOW PERFORMANCE	107.6	108.6	33.7	40.5	199.6
SMALL CAP - HIGH PERFORMANCE	136.8	121.9	57.5	62.5	255.9
SMALL CAP - MIDDLE PERFORMANCE	90.7	89.8	34.5	22.8	171.3
SMALL CAP - LOW PERFORMANCE	278.3	132.0	573.4	90.5	2702.6

Table 27. Statistical processes: Difference Between % Change in Prices and Trading

The figure below shows that technical analysis generally produces better results above the increase of stock prices for large firms.

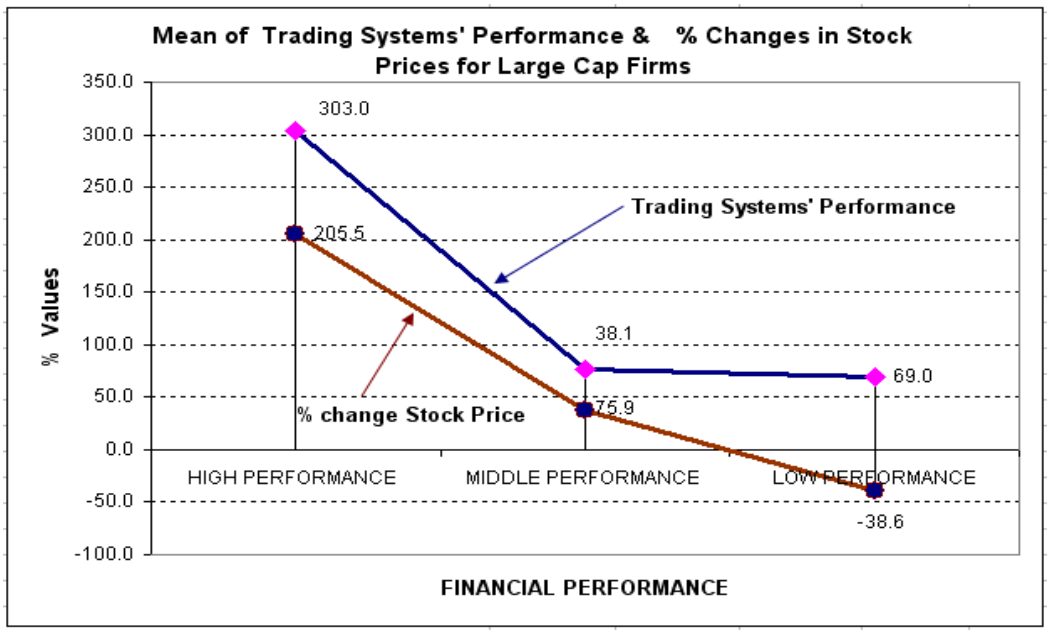


Figure 34. Mean: % Changes in Stock Prices and Trading for Large Capitalization Firms

The figure below shows that in small firms, technical analysis typically produces better results above the increase in stock prices. The increase is the greatest for firms with low financial performance.

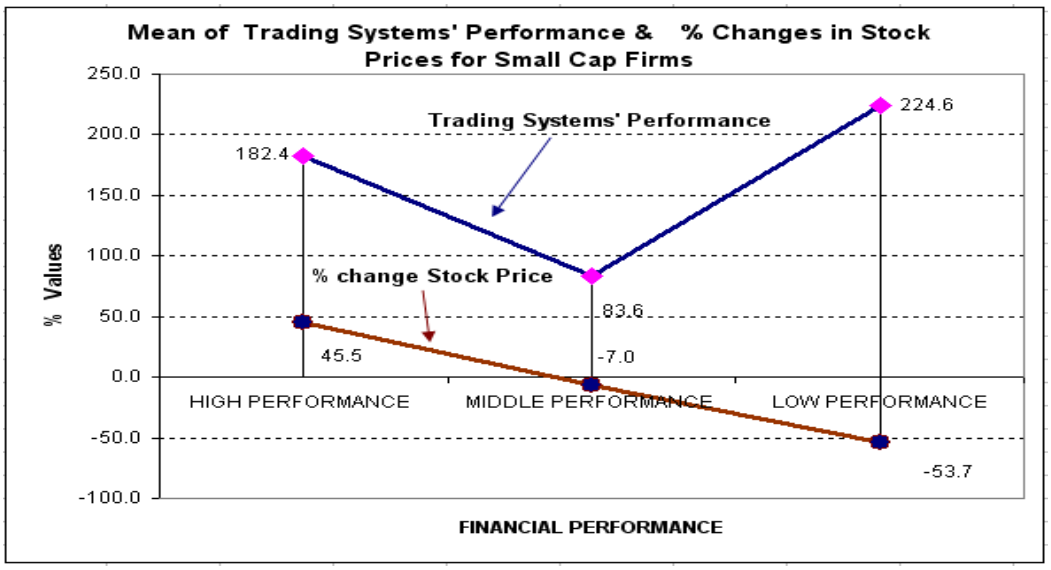


Figure 35. Mean: % Changes in Stock Prices and Trading for Small Capitalization Firms

The figure below depicts the contribution (difference) of technical analysis beyond the change in stock prices. The contribution of technical analysis is greater for small firms with low financial performance.

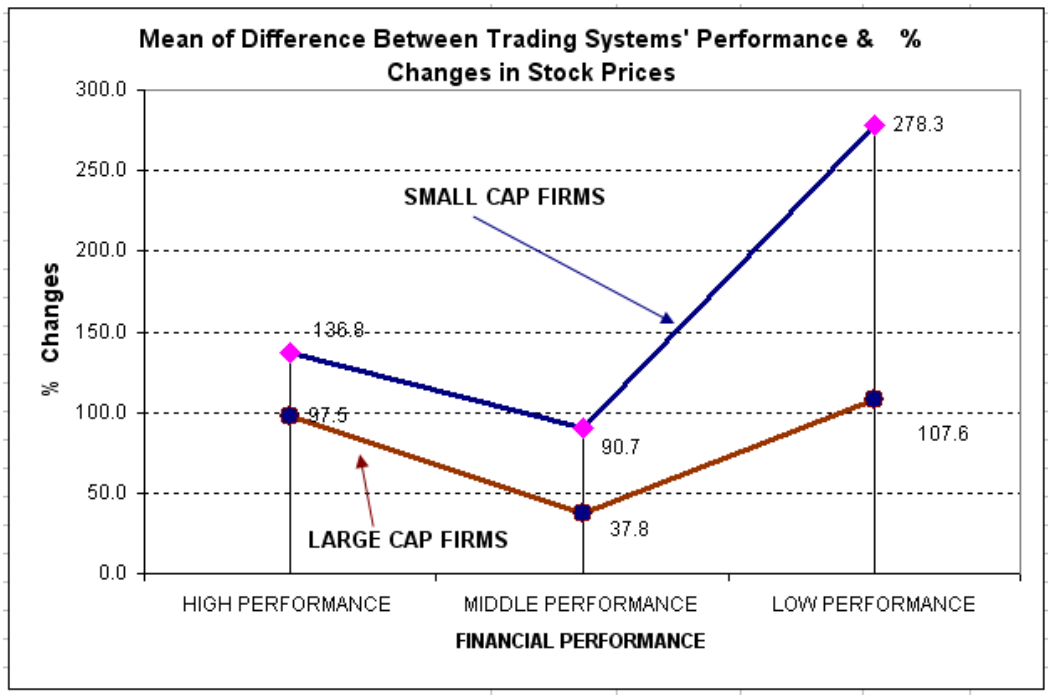


Figure 36. Mean of differences between Change in Prices and Trades

e. Relation Between the Number of Trades and Stocks

Trading systems produce signals for buying and selling. The next statistical process was to find any relationship between the number of trades and their success with the categories of firms (large/small and high/middle/low performance). The next table depicts the statistical results of the number of trades. The least number of trades for large firms is performed for the firms with high performance; the opposite is true for small firms.

Number of Total Trades of Efficient Technical Indicators					
	Mean	Median	Stdv	Min	Max
LARGE CAP - HIGH PERFORMANCE	36.6	31.0	19.4	10.0	64.0
LARGE CAP - MIDDLE PERFORMANCE	50.8	50.0	13.6	29.0	87.0
LARGE CAP- LOW PERFORMANCE	56.8	56.0	9.5	30.0	74.0
SMALL CAP - HIGH PERFORMANCE	49.9	50.5	14.8	22.0	71.0
SMALL CAP - MIDDLE PERFORMANCE	48.7	48.0	9.3	28.0	64.0
SMALL CAP - LOW PERFORMANCE	39.3	35.0	17.6	7.0	76.0

Table 28. Statistical Results: Number of Trades – Firms' Categories

The next table presents the statistical results of the percentage of the successful number of total trades and the six firms' categories.

% Successful Trades of Total Trades					
	Mean	Median	Stdv	Min	Max
LARGE CAP - HIGH PERFORMANCE	58.3	57.9	5.4	50.0	70.0
LARGE CAP - MIDDLE PERFORMANCE	58.9	59.3	4.1	49.4	66.0
LARGE CAP- LOW PERFORMANCE	50.9	51.0	3.7	44.9	57.1
SMALL CAP - HIGH PERFORMANCE	54.0	54.6	4.3	44.2	62.5
SMALL CAP - MIDDLE PERFORMANCE	52.8	52.8	3.9	42.9	59.1
SMALL CAP - LOW PERFORMANCE	47.7	48.2	6.2	29.2	57.1

Table 29. Statistical Results: % Successful Trades – Firms' Categories

The next figure compares the number of trades between large and small firms.

- The number of total trades is almost the same for both large and small firms with a middle financial performance.
- The number of total trades for small firms is less than those of large firms with a high financial performance.
- The number of total trades for small firms is greater than those of large firms with a low financial performance.

The next figure shows the mean of the percentage of successful trades. Trades of large firms are more successful than trades of small firms.

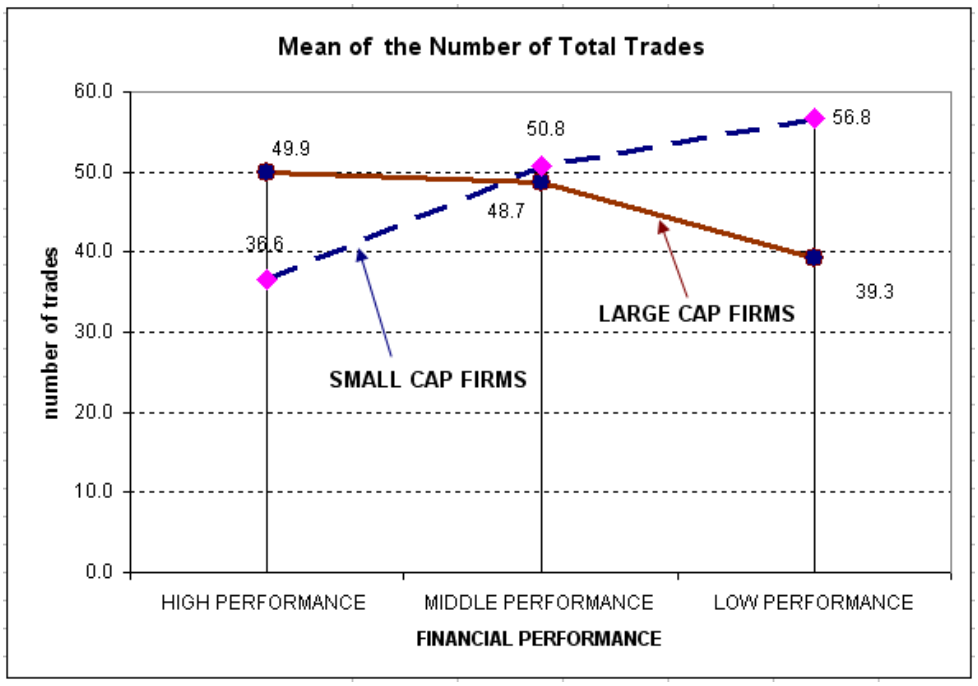


Figure 37. Mean of the Number of Total Trades

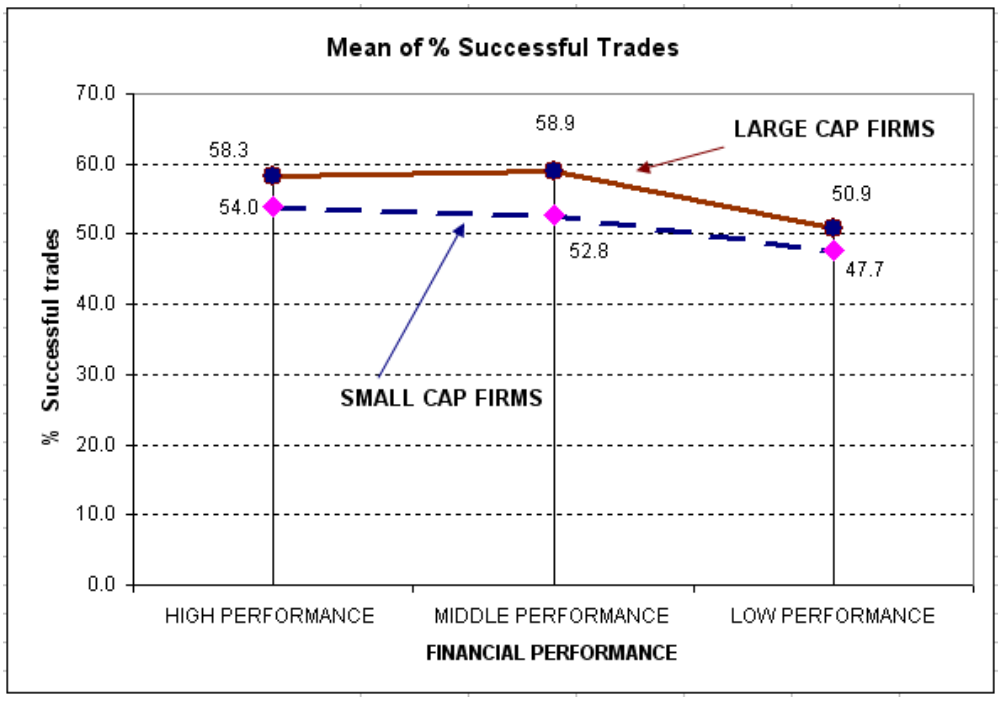


Figure 38. Mean of % successful Trades

f. Regression Analysis

The final step of applying statistical analysis is to apply regression analysis to individual firms in the same category. The correlation between the percentage of changes in stock prices and the performance of trading systems over a specific period of time (from February 2005 to April 2008) was calculated. The next table is an example of these calculations, and refers to large firms with high financial value.

Company	Ticker	% Change Stock Prices	% Performance of Best Trade
Apple Inc	AAPL	**479.62**	**540.20**
Coach Inc	COH	**24.10**	**103.33**
Dish Network Cp	DISH	**1.98**	**82.37**
Genentech Inc	DNA	**29.50**	**104.15**
Emc Corp -Mass	EMC	**8.35**	**85.79**
Gilead Sciences	GILD	**208.99**	**245.81**
Google Inc-Cl A	GOOG	**182.77**	**314.93**
Garmin Ltd	GRMN	**46.67**	**303.45**
Goldman Sachs	GS	**84.26**	**147.58**
Infosys Tec-Adr	INFY	**27.22**	**106.85**
Mastercard Inc	MA	**527.82**	**611.67**
Nvidia Corp	NVDA	**186.64**	**403.67**
Precision Castp	PCP	**287.37**	**335.63**
Potash Sask	POT	**628.23**	**746.79**
Public Storage	PSA	**69.64**	**140.96**
Research In Mot	RIMM	**402.54**	**567.67**
Turkcell Il-Adr	TKC	**60.38**	**173.51**
Vimpel-Comm-Adr	VIP	**400.45**	**496.51**
Xto Energy Inc	XTO	**248.06**	**246.22**

Table 30. Firms' Variables: % Change of Stock Prices & Trading

The correlation of the above variables is 0.954. The same calculations are performed in the next table, as well the rest of the categories of firms. From these results, it can be concluded that

- High performance of technical analysis is related to changes in stock prices over a long period of time for large capitalized

companies. Price changes are related to the financial value of firms; therefore technical and fundamental analyses are highly related in positive ways.

- The performance of technical analysis is related to changes in stock prices over a long period of time for small capitalized companies, but only for the firms that are financially stable (middle and high level). There is no correlation between changes in stock prices and trading performance for small firms with a low financial performance. This means that the performance of trading is independent of the changes in stock prices; therefore technical and fundamental analyses are not related in this situation.

	Correlation
LARGE CAP - HIGH PERFORMANCE	0.954
LARGE CAP - MIDDLE PERFORMANCE	0.854
LARGE CAP- LOW PERFORMANCE	0.724
SMALL CAP - HIGH PERFORMANCE	0.924
SMALL CAP - MIDDLE PERFORMANCE	0.608
SMALL CAP - LOW PERFORMANCE	0.069
SMALL CAP - LOW PERFORMANCE – All firms except one	0.455

Table 31. Correlation Results

Note: The last row in the table above refers to all firms except one which has an extremely high value and distorts the results.

The next figure displays the correlation values for each category of firms. The relationship in small firms is less than those in large firms.

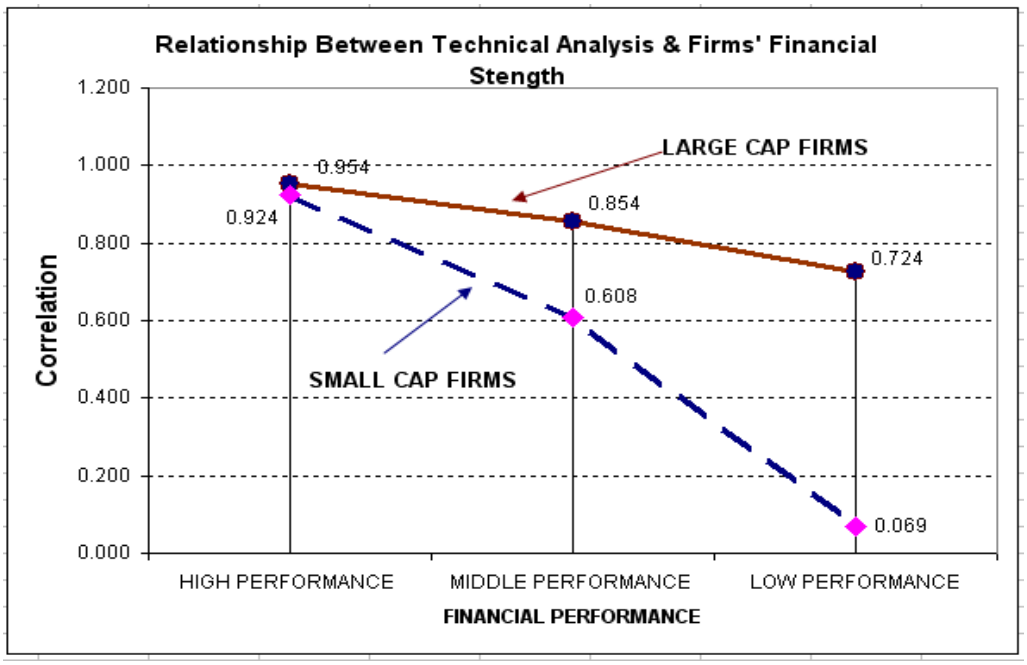


Figure 39. Correlation – All firms' Categories

The next diagrams are XY Scatter plots, which represent the relationships between the two variables in more detail.

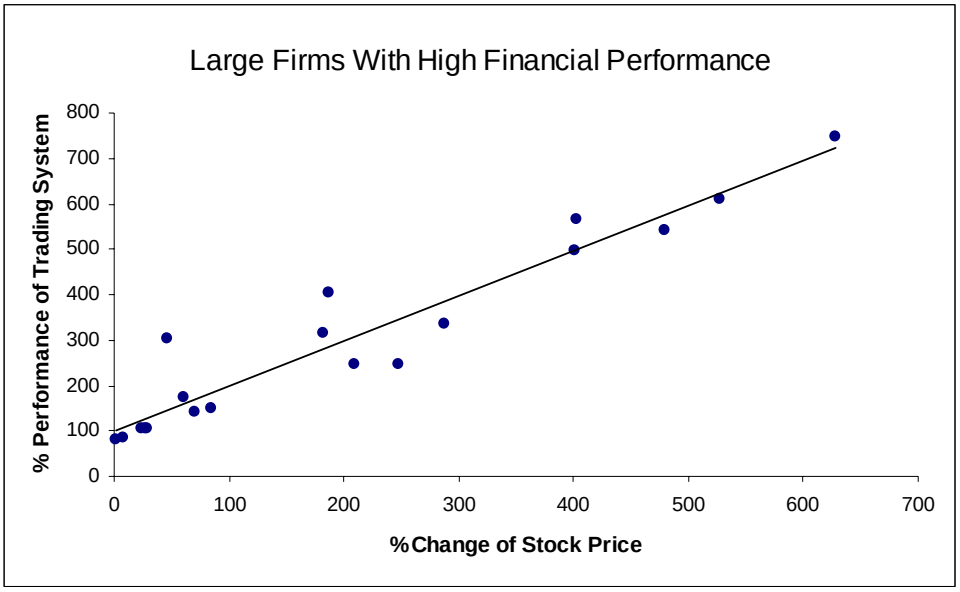


Figure 40. XY Scatter for Large & High Performance Firms

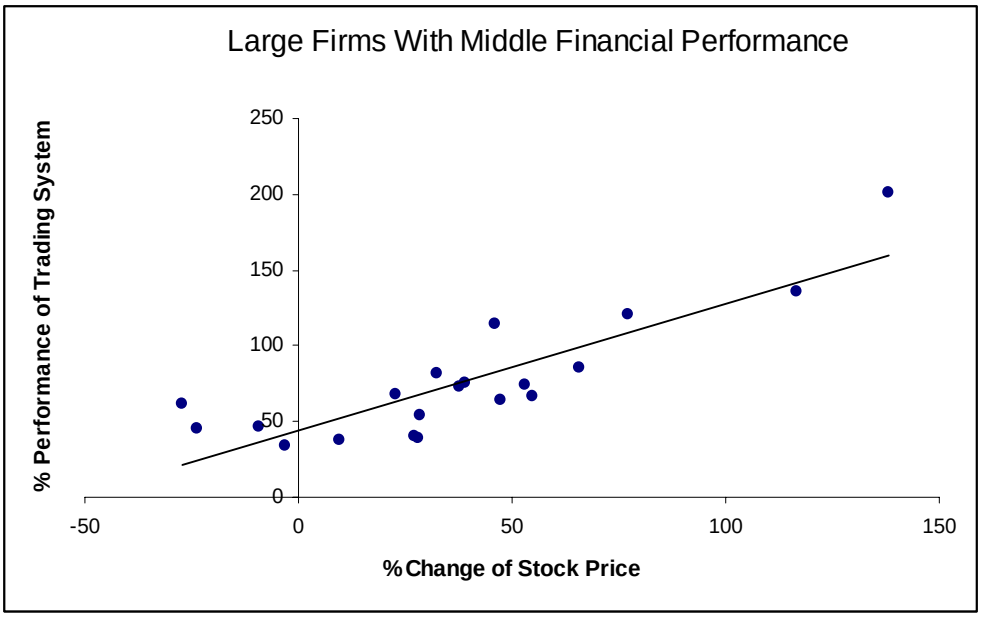


Figure 41. XY Scatter for Large & Middle Performance Firms

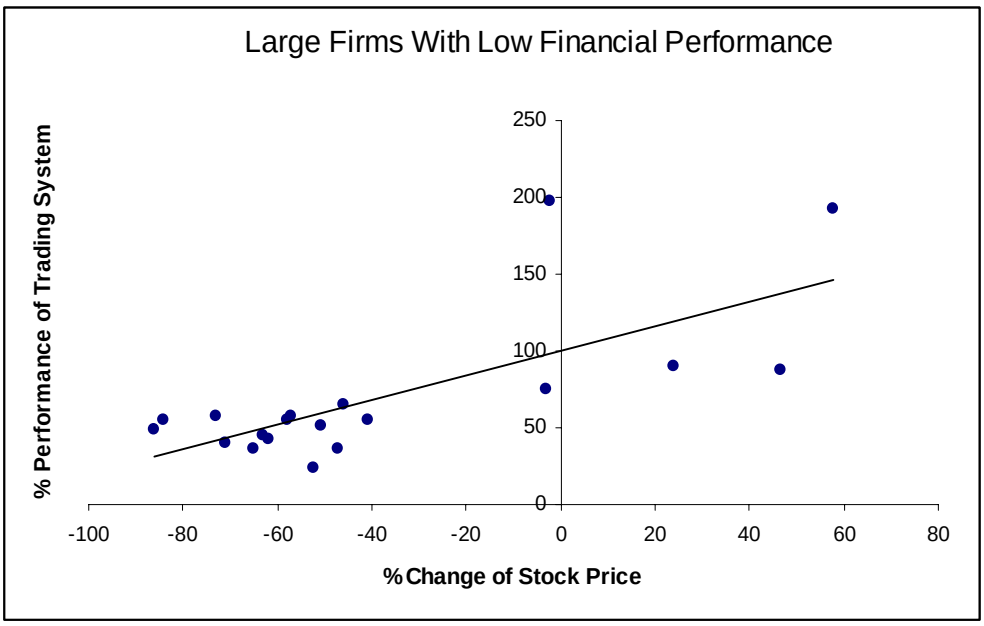


Figure 42. XY Scatter for Large & Low Performance Firms

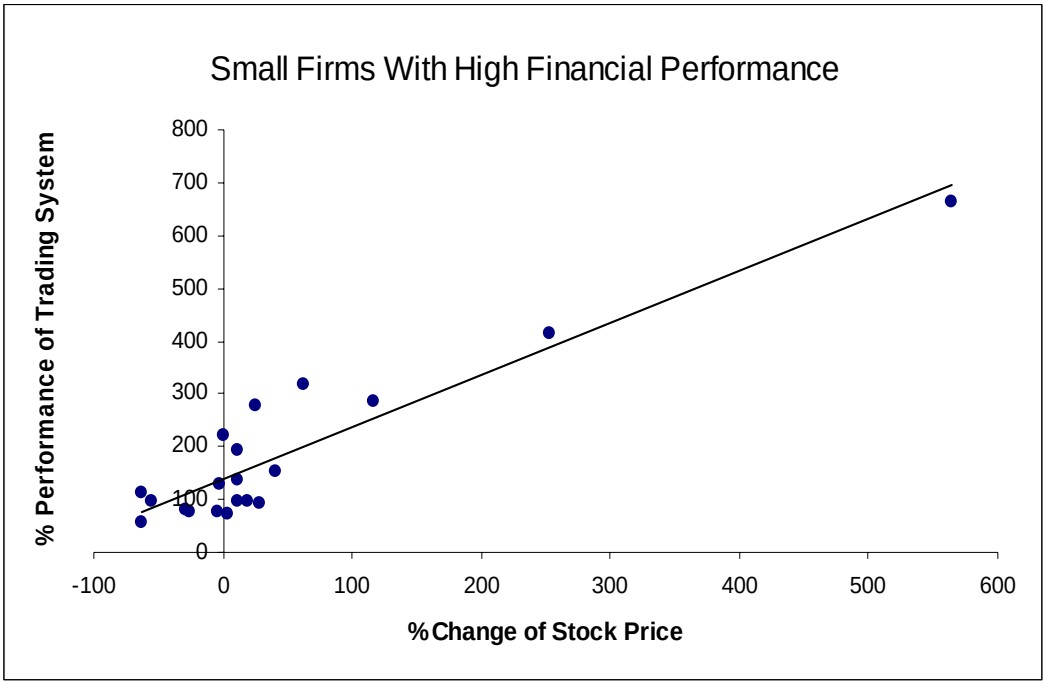


Figure 43. XY Scatter for Small & High Performance Firms

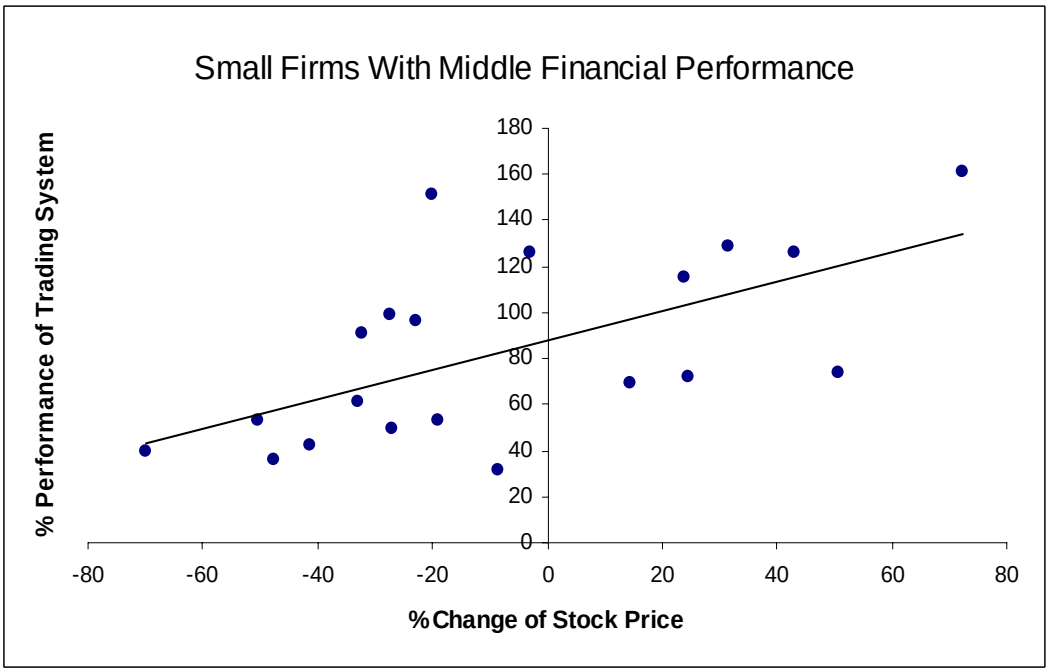


Figure 44. XY Scatter for Small & Middle Performance Firms

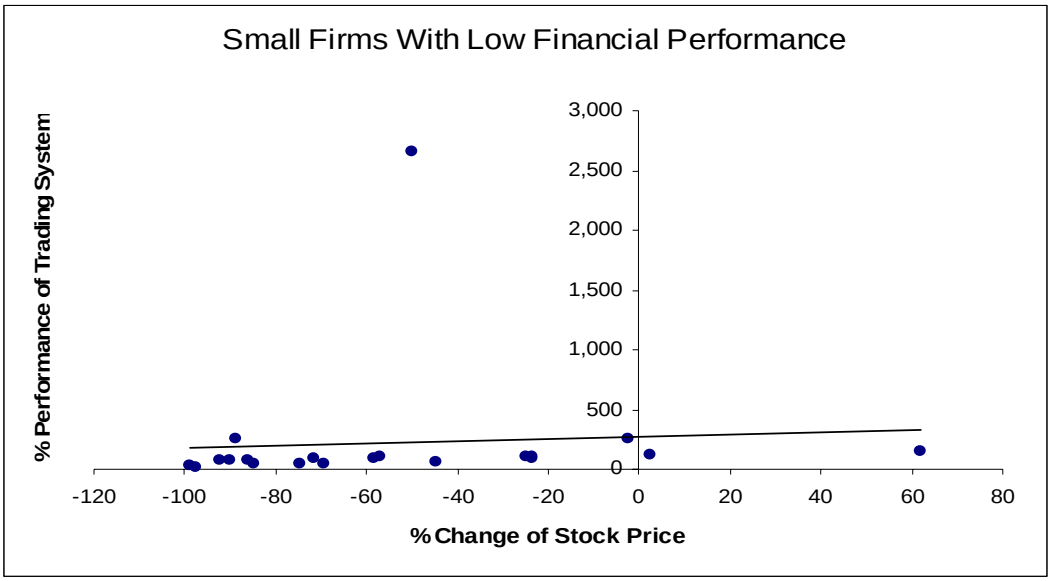


Figure 45. XY Scatter for Small & Low Performance Firms

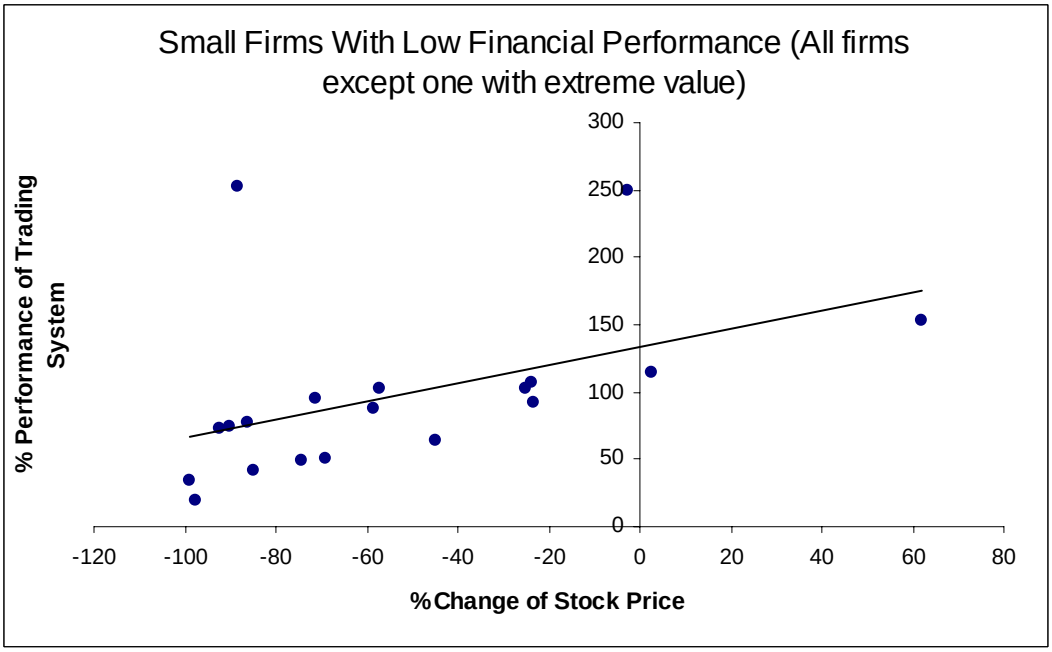


Figure 46. XY Scatter for Small & Low Performance Firms except one Firm

In the above figure, we observe that without the firm having extreme value there is some relation 0.455 but it is relevantly low compared with others above.

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V. CONCLUSION

A. PATTERNS DISCOVERY

This research worked in two different directions. One area concerned the discovery of new patterns that can help to predict future price directions using data mining techniques. The other direction was the exploration of the relationship between fundamental and technical analysis in order to produce the maximum return on investment by using this relationship efficiently.

To discover new patterns, a proper knowledge representation model was developed. All relevant information about stock elements (Open, High, Low, Close) was analyzed and translated (binary number) according to the specifications of the model. The results of applying the custom algorithm were satisfactory and actually discovered profitable patterns beyond the well-known candlesticks. These patterns can be detected by using proper software tools, and assist during investment decisions.

There are several advantages of discovering these patterns. They can predict the future direction of stock prices many days in advance (in some cases 10 ahead). The probability of successful predicting price directions can exceed 65%, and in some cases reaches over 90%. It was also discovered that the continuation of bullish and bearish patterns can help to know when to remain or exit from the market. It was found that reverse patterns can be discovered one or two days earlier.

However, there are some disadvantages. The patterns that predict the future with high probability rarely appear. This means that the method of pattern discovery can only be applied as a secondary tool to support investment decisions.

To use these results most efficiently, we should develop proper software for detecting these patterns. Furthermore, proper technical trading systems should be combined with patterns to maximize profit. The data mining algorithm applied in the U.S.

stock market could be applied in foreign stock markets or in other types of investment instruments such as the Foreign Exchange, Futures, Options, etc. The initial approach is worth further research.

There is room for further research of new patterns. Improvements can be made by using additional information such as volume or involving new rules between candlesticks. Here, the research was focused on patterns consisting of four candlesticks, but could be expanded to study patterns of two, three, five or more.

B. EXPLOITING BOTH FUNDAMENTAL AND TECHNICAL ANALYSES

This research worked to discover any relationship between methods of fundamental and technical analysis. The results of this can help use these analyses to efficiently maximize the return on investments. In the world investment communities there are both supporters and opponents for each of these two methods. Some traders make investments based only on technical analysis and others based only on fundamental analysis. Others use both of these methods, but independently of one another. This approach was to first find the relationship between fundamental and technical analysis because they could be combined to create better results. The results helped develop an investment strategy that obtained the greatest profitable trades and reduced risk.

First, we found that stock prices are reflected by their financial value over a long period of time. Moreover, we found that the size of the firm is related positively to stock prices over a long period of time. Therefore, both the size of a firm and its financial value are related positively to the increase in stock price over a long period of time.

The next important discovery was the relationship of financial value to the performance of trading systems. We compared the mean and median of each firm category. The mean of the trading performance of large firms was decreasing compared to the firm category having less financial value. This implies a relationship between the large firm category and the performance of the trading systems. However, the exception was small firms with low financial values. The performance of the trading systems of low financial value firms was greater than those with high financial value. This finding does not mean that we should include these firms in our portfolio.

In order to further analyze this relationship, regression analysis was applied to individual firms in the same category. The analysis of price changes and the corresponding performance of trading systems revealed a close relationship between the change in stock prices and the performance of trading systems. This relationship was high for large firms, but in small firms there was only a relationship among firms with moderate or high financial performance. The exception was small firms with low financial performance. This can be explained by its high deviation.

In order to better understand the relationship between fundamental and technical analyses, we analyzed the contribution of technical analysis to the return of investment by subtracting the change (increase or decrease) of stock price. In this case we found that technical analysis contributes more to firms with low financial performance and less to firms with moderate financial value.

By summarizing the results above, it can be concluded that both fundamental and technical analyses are related to changes in stock prices over a long period of time.

C. IMPROVING THE PERFORMANCE OF GOVERNMENT RETIREMENT PLANS

The results of this research can help fund managers more efficiently reduce risk, particularly among the retirement plans that involve the selection of stocks in a portfolio. Such plans could be the Thrift Saving Plan referred to Common Stock Index Investment C Fund, Small Capitalization Stock Index Investment S Fund and Individual Retirement Accounts (IRAs). Additionally, it can be applied by individuals to make investment decisions in their portfolio.

It was found that both fundamental and technical analysis, when combined properly, can produce better results with less risk. The proposed strategy for making investment decisions is the following:

- Find stocks with the best financial fundamental values using fundamental indicators such as ratios. This can be done by using stock screeners and applying fundamental filter criteria.

- Apply back testing to the fundamental filter criteria of the work.
- Prefer large stocks (book value > $5 B) which have increased probability of investment return and less risk of loss. Small stocks should be second preference.
- Apply technical analysis to the selected portfolio. Trading signals produced by trading systems should be optimized for the most profitable results.
- Make use of the alerts produced by the discovered candlestick patterns and combine decisions with technical analysis.

The methods proposed require individuals to have proper knowledge and experience. Investments in stocks can lose money. The above analysis represents a method to better ensure the efficient use of the investor's assets.

APPENDIX

A. TABLES FROM CHAPTER III

The following table depicts the selected patterns referred to the best predictions of stock prices to increase the day 1 with possibility more than 70%.

FREQ	Pattern of 4	Next 1	Next 2	Next 3	Next 4	Next 5	Next 6	Next 7	Next 8	Next 9	Next 10
19	1000000000000001011100100100100	94.7	79.0	79.0	68.4	52.6	57.9	57.9	57.9	68.4	73.7
16	0000000000000010101101000100100	93.8	68.8	50.0	50.0	50.0	50.0	62.5	56.3	62.5	50.0
20	1000010000000001011110110010010	90.0	85.0	75.0	75.0	60.0	55.0	50.0	60.0	60.0	60.0
15	1000000000101101000001001011101	86.7	73.3	66.7	66.7	73.3	66.7	73.3	80.0	80.0	73.3
15	1001000000000000000001110100010	86.7	60.0	46.7	53.3	53.3	66.7	66.7	66.7	46.7	60.0
19	1000000000101101000000101011101	84.2	68.4	79.0	68.4	68.4	73.7	63.2	57.9	68.4	79.0
17	1001100000000000011000010100010	82.4	70.6	70.6	64.7	76.5	76.5	82.4	82.4	88.2	82.4
17	1011100000010010000001000100010	82.4	64.7	70.6	64.7	64.7	64.7	58.8	64.7	52.9	58.8
16	0001000000000000101101000100010	81.3	68.8	56.3	68.8	75.0	81.3	68.8	87.5	75.0	81.3
16	1000000000110110000000101010010	81.3	68.8	75.0	62.5	68.8	62.5	75.0	68.8	75.0	75.0
16	1000000110000000011000100100010	81.3	81.3	81.3	62.5	62.5	62.5	75.0	81.3	62.5	68.8
21	0000011011000001000010100100100	81.0	81.0	90.5	71.4	66.7	76.2	71.4	61.9	81.0	81.0
26	1000010000000010000010111011010	80.8	53.9	53.9	57.7	50.0	50.0	42.3	53.9	65.4	46.2
15	1000000000101100000000011010001	80.0	66.7	53.3	73.3	80.0	60.0	73.3	66.7	73.3	80.0
20	1000010000110010101110111010010	80.0	60.0	60.0	45.0	45.0	40.0	45.0	50.0	50.0	70.0
15	0000010000000001101110100100101	80.0	60.0	60.0	53.3	66.7	66.7	73.3	60.0	60.0	66.7
20	0000010000001101000011000010101	80.0	55.0	65.0	60.0	65.0	55.0	60.0	55.0	60.0	65.0
15	0001000000100111000001001010101	80.0	80.0	66.7	80.0	73.3	73.3	66.7	66.7	66.7	60.0
20	0101100000100000000001001100001	80.0	65.0	75.0	70.0	70.0	55.0	70.0	65.0	65.0	55.0
15	0011100000000001011001000100101	80.0	66.7	53.3	66.7	46.7	53.3	53.3	60.0	60.0	53.3
15	1100110000110110000010111011010	80.0	40.0	40.0	60.0	46.7	46.7	53.3	60.0	53.3	53.3
15	0011010000100000100110111011001	80.0	33.3	46.7	46.7	33.3	40.0	46.7	46.7	46.7	53.3
19	1011010111000000000010110100010	79.0	84.2	84.2	94.7	84.2	73.7	73.7	84.2	73.7	63.2
28	0100100000000000011101000100101	78.6	60.7	53.6	57.1	64.3	64.3	71.4	75.0	67.9	67.9
23	0000010110000001000010100001101	78.3	65.2	60.9	69.6	69.6	78.3	73.9	69.6	69.6	65.2
23	0011000000000000011010001000100	78.3	69.6	65.2	56.5	69.6	65.2	60.9	56.5	52.2	56.5
27	1000000000000001001001000100101	77.8	59.3	40.7	48.2	51.9	55.6	55.6	55.6	63.0	63.0
18	1000000001000011001000111001011	77.8	66.7	61.1	61.1	61.1	72.2	66.7	66.7	61.1	61.1
17	0101110000100000011010111011001	76.5	70.6	47.1	58.8	64.7	70.6	76.5	70.6	70.6	76.5
17	0000000110000010000010000011011	76.5	64.7	70.6	76.5	58.8	64.7	64.7	64.7	70.6	70.6
17	0000011011100001011110101011011	76.5	64.7	64.7	76.5	76.5	70.6	64.7	70.6	70.6	64.7
17	0000010000001100000010110010001	76.5	64.7	76.5	58.8	52.9	47.1	52.9	52.9	58.8	58.8
21	1000010000000001101110110010110	76.2	61.9	52.4	47.6	42.9	47.6	42.9	42.9	57.1	66.7
21	1000010000100000001010111011010	76.2	76.2	66.7	57.1	52.4	57.1	57.1	47.6	47.6	47.6
16	0000010000000000001010110100010	75.0	43.8	62.5	56.3	68.8	68.8	68.8	62.5	81.3	75.0
16	0011000001000010011010010111011	75.0	68.8	75.0	75.0	68.8	75.0	75.0	75.0	75.0	75.0

20	10000101101100100000101110110100	75.0	70.0	70.0	70.0	55.0	60.0	60.0	65.0	70.0	75.0
20	10000110011101110000101110111011	75.0	65.0	60.0	55.0	65.0	65.0	65.0	70.0	70.0	70.0
16	00000100000000001011110000111010	75.0	62.5	56.3	62.5	50.0	56.3	56.3	62.5	62.5	68.8
16	01011000110000000000101101000100	75.0	62.5	50.0	43.8	43.8	50.0	68.8	62.5	56.3	68.8
16	00000100000100110000101110111011	75.0	43.8	50.0	50.0	50.0	43.8	56.3	56.3	56.3	68.8
20	00110001110000000000010001000100	75.0	75.0	75.0	70.0	65.0	50.0	50.0	55.0	75.0	65.0
20	10110100001000000000100110110100	75.0	90.0	75.0	75.0	60.0	55.0	55.0	65.0	65.0	65.0
16	00110000000000000111010001001010	75.0	75.0	62.5	68.8	75.0	62.5	68.8	62.5	62.5	62.5
24	10000100001011010000101100101001	75.0	75.0	66.7	66.7	66.7	50.0	50.0	58.3	62.5	62.5
16	00000000110011100000010001000100	75.0	62.5	62.5	62.5	68.8	68.8	62.5	62.5	56.3	62.5
20	10000101101100100000101110110001	75.0	60.0	70.0	70.0	80.0	70.0	65.0	70.0	60.0	60.0
20	01001100000000010000101100101011	75.0	80.0	60.0	65.0	65.0	55.0	70.0	65.0	60.0	60.0
16	10011010010000000000010001000100	75.0	75.0	50.0	68.8	56.3	56.3	75.0	68.8	56.3	56.3
16	10000100001000010000101010111011	75.0	56.3	50.0	62.5	56.3	56.3	75.0	62.5	56.3	56.3
16	00000100000011010000100100101001	75.0	43.8	50.0	62.5	56.3	56.3	50.0	50.0	50.0	56.3
16	10000001111000000000001010110001	75.0	50.0	37.5	68.8	50.0	56.3	56.3	43.8	56.3	50.0
16	00000101111011110000101010111011	75.0	62.5	50.0	43.8	43.8	56.3	56.3	50.0	56.3	43.8
16	00000110011100100000101010110001	75.0	81.3	68.8	68.8	50.0	50.0	50.0	56.3	43.8	43.8
19	00110010110000000000010001000100	73.7	63.2	79.0	68.4	73.7	63.2	57.9	57.9	57.9	73.7
19	00000100000011000000100100110100	73.7	73.7	63.2	47.4	42.1	36.8	42.1	47.4	52.6	57.9
19	00000100000000011001101100101010	73.7	57.9	42.1	26.3	31.6	26.3	31.6	31.6	31.6	42.1
15	10000110110000000000101101110100	73.3	73.3	73.3	66.7	66.7	66.7	66.7	73.3	66.7	80.0
15	00110100001001110000101110111011	73.3	80.0	66.7	73.3	73.3	60.0	60.0	66.7	73.3	73.3
15	00000001100000000000101101000100	73.3	80.0	73.3	73.3	66.7	66.7	73.3	73.3	73.3	66.7
15	10011100001000000111101110110010	73.3	80.0	80.0	73.3	53.3	60.0	66.7	66.7	66.7	66.7
15	00001000001000000000010010110100	73.3	80.0	66.7	60.0	60.0	60.0	60.0	60.0	60.0	66.7
15	10000100000101110000101100100100	73.3	53.3	53.3	66.7	66.7	66.7	73.3	73.3	73.3	60.0
15	00000000000101100111010010100100	73.3	60.0	66.7	53.3	73.3	66.7	60.0	60.0	60.0	60.0
30	10000000000000010000101101001100	73.3	53.3	43.3	50.0	46.7	46.7	50.0	53.3	53.3	60.0
15	00000100001000000010101010110010	73.3	53.3	60.0	46.7	60.0	60.0	53.3	60.0	60.0	53.3
15	00111100001000001001101110110010	73.3	73.3	86.7	73.3	60.0	53.3	53.3	53.3	53.3	53.3
30	00110000001000000000010010100100	73.3	73.3	66.7	63.3	60.0	53.3	56.7	63.3	60.0	46.7
15	01001100001000001001101110110011	73.3	60.0	53.3	60.0	66.7	53.3	46.7	40.0	40.0	46.7
15	10000000000000010000000101000100	73.3	60.0	40.0	53.3	53.3	46.7	53.3	46.7	33.3	33.3
26	10000100010000010000101101001100	73.1	73.1	69.2	65.4	65.4	69.2	61.5	65.4	57.7	61.5
22	00011001111000010000010010111011	72.7	63.6	68.2	77.3	68.2	68.2	77.3	63.6	68.2	63.6
22	00000010010001100000010001000100	72.7	54.6	59.1	50.0	59.1	63.6	63.6	68.2	59.1	59.1
18	00000100101000000000101010110001	72.2	66.7	50.0	55.6	72.2	61.1	72.2	77.8	72.2	72.2
18	10111000000000001001010001000100	72.2	61.1	55.6	66.7	55.6	66.7	61.1	66.7	61.1	66.7
18	10000010011000001001001010010010	72.2	61.1	50.0	55.6	61.1	55.6	55.6	66.7	66.7	61.1
18	10000100001101100110101110110100	72.2	61.1	55.6	61.1	50.0	44.4	50.0	50.0	61.1	55.6
18	00001100000000000000101100100100	72.2	72.2	66.7	61.1	55.6	50.0	61.1	44.4	38.9	50.0
25	10000100000000010011101100110100	72.0	60.0	56.0	56.0	68.0	68.0	72.0	68.0	68.0	72.0
25	00010100000000000000101100100100	72.0	72.0	72.0	72.0	64.0	60.0	68.0	60.0	64.0	56.0
32	10010100001000000000101110110001	71.9	68.8	56.3	59.4	59.4	59.4	56.3	53.1	56.3	53.1
21	00000000001001110011010010101011	71.4	66.7	61.9	61.9	57.1	71.4	71.4	81.0	76.2	81.0
28	01011000000000010000000101001001	71.4	64.3	64.3	57.1	57.1	60.7	57.1	60.7	71.4	67.9
21	10000110011000000000101110010010	71.4	76.2	71.4	85.7	66.7	66.7	71.4	57.1	66.7	61.9
28	10000000001011100000001110100001	71.4	71.4	67.9	60.7	64.3	64.3	64.3	60.7	60.7	53.6

28	00000100001100100000101010110001	71.4	50.0	53.6	64.3	64.3	50.0	39.3	39.3	50.0	42.9
35	10000100000000010110101100111100	71.4	60.0	60.0	48.6	51.4	54.3	48.6	48.6	42.9	40.0
21	10000110011000000111101110110010	71.4	71.4	38.1	42.9	42.9	38.1	42.9	28.6	28.6	28.6
45	10000100000000010111101101001010	71.1	44.4	53.3	46.7	57.8	48.9	48.9	46.7	51.1	48.9
31	00000000000000010010010001001011	71.0	71.0	71.0	61.3	58.1	61.3	67.7	61.3	67.7	67.7
31	10000000110000000000001000010100	71.0	51.6	54.8	51.6	51.6	58.1	61.3	61.3	71.0	58.1
24	10000000001001100000000110100001	70.8	75.0	66.7	58.3	58.3	58.3	66.7	62.5	66.7	62.5
24	10110110110000000000101100010100	70.8	66.7	66.7	62.5	62.5	58.3	66.7	62.5	58.3	62.5
24	00000100011000000000110010110011	70.8	66.7	54.2	58.3	62.5	62.5	58.3	58.3	62.5	58.3
24	00000000000001100000010010100001	70.8	62.5	62.5	54.2	54.2	54.2	54.2	45.8	50.0	58.3
24	00000100000000001011101101000100	70.8	58.3	54.2	45.8	37.5	50.0	41.7	45.8	62.5	54.2
41	10011000000000010000000101001100	70.7	53.7	68.3	63.4	61.0	61.0	65.9	68.3	61.0	56.1
17	00000000000101100111010001000100	70.6	64.7	58.8	58.8	70.6	76.5	88.2	88.2	70.6	82.4
17	01001000001001100000010010100100	70.6	76.5	70.6	76.5	76.5	70.6	64.7	58.8	82.4	70.6
17	00000101111000010110101010111011	70.6	88.2	76.5	76.5	70.6	70.6	70.6	70.6	76.5	70.6
17	10000000000000010000010010101011	70.6	58.8	52.9	47.1	41.2	52.9	47.1	64.7	70.6	64.7
17	10000000000000010110010001001011	70.6	64.7	64.7	58.8	58.8	76.5	64.7	64.7	64.7	64.7
17	01011000001000000000010010100001	70.6	58.8	70.6	58.8	64.7	70.6	58.8	64.7	64.7	64.7
17	00000100000011000000101010110100	70.6	64.7	52.9	76.5	82.4	58.8	64.7	58.8	58.8	64.7
17	11001100001000011011101110110010	70.6	64.7	58.8	58.8	52.9	64.7	52.9	58.8	52.9	64.7
17	10000000001001010000001010101011	70.6	52.9	52.9	52.9	52.9	64.7	47.1	58.8	64.7	52.9
17	00000000001000001011010010110011	70.6	82.4	82.4	58.8	52.9	58.8	64.7	52.9	64.7	52.9
17	00111000000011100000010001000100	70.6	58.8	41.2	58.8	58.8	52.9	52.9	47.1	64.7	52.9
17	10110100000101110000101100101001	70.6	58.8	82.4	52.9	76.5	64.7	58.8	58.8	58.8	52.9
17	11001100001100100000101110110100	70.6	58.8	47.1	58.8	64.7	52.9	52.9	52.9	52.9	52.9
17	00000000110000010000101001001001	70.6	58.8	76.5	47.1	47.1	47.1	41.2	41.2	47.1	52.9
17	10000100000000010110101100010100	70.6	70.6	47.1	47.1	41.2	58.8	47.1	41.2	52.9	47.1
17	10000000000101100000001001000001	70.6	52.9	41.2	52.9	58.8	64.7	52.9	52.9	58.8	35.3
27	00000100000000010000101100011011	70.4	70.4	74.1	66.7	70.4	66.7	63.0	74.1	66.7	74.1

The following table depicts the selected patterns referred to the best predictions of stock prices to decrease the day 1 with possibility more than 70%.

FREQ	Pattern of 4	Next 1	Next 2	Next 3	Next 4	Next 5	Next 6	Next 7	Next 8	Next 9	Next 10
15	0001100000000001100101000100101	0	86.7	80.0	80.0	66.7	60.0	66.7	53.3	66.7	66.7	66.7
21	0100110000100001011110011011011	0	85.7	61.9	52.4	57.1	47.6	66.7	52.4	57.1	52.4	47.6
31	0000000011010000000000100101100	01	83.9	61.3	58.1	58.1	61.3	54.8	48.4	48.4	38.7	51.6
17	1000100000100001000001001010101	1	82.4	64.7	58.8	58.8	47.1	58.8	35.3	23.5	35.3	29.4
17	1000010111100000000000101011001	1	82.4	76.5	58.8	64.7	58.8	64.7	52.9	58.8	47.1	52.9
16	0100100000100001001101001011101	1	81.3	68.8	75.0	81.3	75.0	81.3	87.5	87.5	68.8	68.8
16	0100110000100101000010011011101	1	81.3	68.8	68.8	62.5	68.8	68.8	75.0	75.0	68.8	75.0
21	1100110000000001000010110011101	0	81.0	66.7	57.1	66.7	66.7	66.7	66.7	66.7	71.4	71.4
21	1000001011100001000000111011101	1	81.0	66.7	66.7	71.4	66.7	61.9	61.9	76.2	71.4	61.9
15	0101110000000001000010110001101	0	80.0	60.0	66.7	60.0	60.0	53.3	60.0	53.3	53.3	60.0
20	0000001000010000000111011101101	1	80.0	75.0	60.0	70.0	70.0	70.0	75.0	65.0	55.0	65.0
20	1000000000100011000000101100101	1	80.0	55.0	70.0	60.0	70.0	65.0	65.0	55.0	45.0	50.0
25	0000000000010000000010100101100	1	80.0	60.0	52.0	60.0	52.0	64.0	60.0	60.0	44.0	48.0
20	1000001001000110000000100100010	0	80.0	65.0	45.0	45.0	45.0	55.0	40.0	35.0	45.0	40.0
20	0100100000100001101101001011101	1	80.0	65.0	50.0	60.0	55.0	50.0	60.0	60.0	55.0	50.0
15	1000000000110010000000101010000	1	80.0	60.0	60.0	60.0	53.3	53.3	40.0	40.0	33.3	26.7
24	1000010000000011000010110011101	1	79.2	54.2	62.5	58.3	62.5	54.2	75.0	58.3	54.2	41.7
19	1000010110100000101110110111011	1	79.0	47.4	47.4	47.4	52.6	42.1	36.8	42.1	36.8	26.3
18	0000000000010000100000100101101	00	77.8	66.7	66.7	55.6	44.4	44.4	38.9	55.6	55.6	61.1
18	1000011011000001000010110100101	0	77.8	66.7	55.6	55.6	50.0	50.0	66.7	61.1	66.7	72.2
18	1000010110101110000010111011010	0	77.8	55.6	55.6	38.9	44.4	44.4	55.6	55.6	55.6	55.6
18	0000000000010000110110100110000	10	77.8	83.3	72.2	66.7	72.2	61.1	66.7	72.2	61.1	55.6
18	1000011001100101000010111011011	1	77.8	66.7	50.0	55.6	61.1	55.6	55.6	61.1	61.1	61.1
21	1000010001100111000010111011011	1	76.2	52.4	61.9	76.2	81.0	66.7	57.1	61.9	57.1	61.9
16	0000000010100001011001001011101	1	75.0	56.3	50.0	37.5	43.8	50.0	43.8	43.8	43.8	43.8
16	0100110000000001000010010011100	0	75.0	75.0	68.8	62.5	56.3	68.8	68.8	75.0	75.0	68.8
24	0000000011100001100101001011101	1	75.0	54.2	66.7	54.2	66.7	50.0	62.5	62.5	54.2	54.2
24	1000000000100001000010111001101	1	75.0	66.7	66.7	50.0	50.0	54.2	54.2	54.2	45.8	50.0
16	0101110000000001000010010001101	0	75.0	68.8	56.3	68.8	62.5	50.0	50.0	43.8	50.0	50.0
16	1000010000000000100110110010101	0	75.0	75.0	56.3	37.5	37.5	43.8	37.5	37.5	43.8	43.8
16	0101110110100001000010011011101	1	75.0	62.5	68.8	62.5	62.5	56.3	62.5	62.5	68.8	62.5
16	0000001000000010000001100001001	00	75.0	68.8	62.5	81.3	68.8	68.8	56.3	81.3	87.5	62.5
20	0000001001100000011101001011001	0	75.0	55.0	60.0	55.0	55.0	65.0	70.0	55.0	60.0	55.0
20	1000000000100000101100111011011	1	75.0	70.0	45.0	55.0	50.0	60.0	60.0	50.0	65.0	45.0
24	0000000000000000000010100010010	1	75.0	70.8	75.0	70.8	75.0	79.2	70.8	66.7	54.2	58.3
16	1000010000000110011110110010010	0	75.0	81.3	56.3	37.5	50.0	50.0	50.0	56.3	50.0	37.5
20	1001010000110011000010111011011	1	75.0	65.0	55.0	65.0	60.0	60.0	60.0	50.0	45.0	45.0
20	1000010011100001001110111011011	1	75.0	75.0	60.0	70.0	70.0	65.0	70.0	75.0	70.0	60.0
16	0000000011000000000001001011010	0	75.0	62.5	50.0	43.8	43.8	43.8	50.0	43.8	43.8	43.8
16	1000010000010010101110111011010	0	75.0	25.0	25.0	18.8	31.3	31.3	43.8	50.0	56.3	56.3
16	0001110000100001100110011011101	1	75.0	50.0	50.0	50.0	37.5	37.5	37.5	50.0	50.0	43.8
20	1000001001100000000000011100100	11	75.0	70.0	65.0	45.0	65.0	60.0	50.0	50.0	55.0	50.0

16	0000000000010011110010100101011	75.0	50.0	50.0	43.8	43.8	50.0	50.0	31.3	37.5	31.3
16	0100100000001101000010001001001	75.0	62.5	56.3	62.5	50.0	56.3	43.8	37.5	50.0	43.8
31	1000000000101101000000101100101 1	74.2	64.5	58.1	48.4	51.6	45.2	48.4	48.4	48.4	41.9
27	1000010000101100000010111011011 1	74.1	70.4	63.0	51.9	48.2	51.9	51.9	44.4	51.9	51.9
23	1000011011010010000010110100010 0	73.9	56.5	47.8	52.2	60.9	47.8	47.8	52.2	52.2	52.2
19	1000000000100000100100101011001 1	73.7	47.4	57.9	52.6	57.9	52.6	47.4	57.9	57.9	57.9
19	1000010000101101000110111011011	73.7	42.1	52.6	57.9	57.9	52.6	47.4	68.4	63.2	63.2
19	1101110000010010000010110010010 0	73.7	57.9	42.1	36.8	36.8	36.8	42.1	36.8	42.1	42.1
19	0100110000100000101110111011001 0	73.7	68.4	52.6	52.6	52.6	42.1	52.6	47.4	42.1	36.8
19	0100110000000000100110110011010 0	73.7	63.2	63.2	68.4	63.2	68.4	52.6	68.4	63.2	42.1
19	1011010000000111000010110010100 1	73.7	68.4	68.4	68.4	73.7	73.7	47.4	47.4	47.4	47.4
19	1000000000000000101100001010011 00	73.7	63.2	63.2	68.4	63.2	73.7	47.4	47.4	52.6	52.6
15	1000000000100001101100111010101 1	73.3	66.7	60.0	53.3	53.3	60.0	66.7	66.7	66.7	60.0
15	0011100000100001100101001011101 1	73.3	60.0	60.0	60.0	53.3	60.0	33.3	40.0	33.3	40.0
15	0000001011100000011101001011001 0	73.3	60.0	73.3	53.3	53.3	60.0	53.3	66.7	53.3	53.3
15	0000010000000001011010010010101 0	73.3	60.0	66.7	60.0	73.3	73.3	60.0	53.3	60.0	60.0
15	1000011011000000100110110100010 0	73.3	60.0	53.3	53.3	60.0	66.7	66.7	60.0	60.0	60.0
15	0000010111000000000010100111010 0	73.3	60.0	80.0	73.3	60.0	40.0	40.0	33.3	40.0	46.7
15	1001000000100001000001001001101 1	73.3	46.7	60.0	60.0	33.3	40.0	53.3	46.7	53.3	46.7
15	1000010010100001001110111011011	73.3	66.7	66.7	60.0	46.7	46.7	53.3	46.7	40.0	40.0
15	0000010000100000000110101011001 1	73.3	33.3	46.7	33.3	40.0	46.7	40.0	46.7	40.0	33.3
15	1000000000000001100100010100101 1	73.3	66.7	53.3	46.7	40.0	40.0	53.3	60.0	66.7	66.7
15	1000010000000001000110110010101 1	73.3	80.0	66.7	66.7	66.7	66.7	66.7	73.3	66.7	73.3
15	1000000011110011000000101011101 1	73.3	40.0	53.3	33.3	53.3	53.3	53.3	53.3	46.7	40.0
15	1001100111000000000010110100010 0	73.3	60.0	60.0	66.7	46.7	53.3	53.3	53.3	53.3	46.7
15	0000001001100000100101001011001 1	73.3	53.3	66.7	60.0	46.7	46.7	46.7	40.0	33.3	33.3
15	1000011001100001000110111011011	73.3	60.0	60.0	40.0	53.3	60.0	53.3	46.7	66.7	66.7
15	1000000000000111000001001010100 1	73.3	66.7	66.7	66.7	73.3	66.7	66.7	60.0	73.3	66.7
15	0000000000100101100101001010101 1	73.3	66.7	40.0	46.7	33.3	46.7	33.3	33.3	33.3	26.7
15	0000010100110000100000100100110 11	73.3	73.3	46.7	46.7	40.0	60.0	46.7	60.0	40.0	40.0
15	0011000000100001101101001011101 1	73.3	66.7	53.3	60.0	60.0	53.3	40.0	40.0	53.3	53.3
15	0000010000001101000011000010100 1	73.3	60.0	46.7	60.0	53.3	66.7	60.0	73.3	53.3	53.3
26	0000000000100001001101001011001 0	73.1	46.2	50.0	50.0	46.2	46.2	46.2	42.3	46.2	50.0
22	0100100000101101000001001100101 1	72.7	59.1	59.1	54.6	59.1	54.6	50.0	68.2	59.1	68.2
18	1011011001100000000010111011010 0	72.2	61.1	61.1	61.1	66.7	55.6	55.6	50.0	38.9	33.3
18	0000010000000001011110100001101 0	72.2	77.8	61.1	72.2	61.1	55.6	44.4	44.4	55.6	50.0
36	1101100000100001000001001001101 1	72.2	50.0	55.6	44.4	41.7	47.2	38.9	33.3	38.9	41.7
18	0000000011101001000001010010001 00	72.2	44.4	61.1	38.9	44.4	44.4	55.6	44.4	38.9	44.4
36	1011100000100001000001001001101 1	72.2	66.7	55.6	55.6	66.7	52.8	47.2	47.2	52.8	52.8
18	1000001001100001001100101001101 1	72.2	72.2	55.6	50.0	50.0	50.0	50.0	44.4	44.4	50.0
18	1011000000010011000001000100100 1	72.2	61.1	55.6	50.0	50.0	61.1	66.7	66.7	55.6	66.7
18	0000010111000000100110100001010 0	72.2	61.1	66.7	66.7	50.0	72.2	55.6	55.6	55.6	50.0
18	0101110000100000100110011011001 1	72.2	61.1	38.9	50.0	61.1	50.0	55.6	55.6	44.4	50.0
18	1000000000010110000000110100000 1	72.2	55.6	33.3	44.4	22.2	38.9	38.9	27.8	27.8	22.2
25	1101110011100001000010111011011	72.0	64.0	68.0	68.0	72.0	72.0	56.0	56.0	56.0	56.0
25	1011010000000001000010110011101 0	72.0	64.0	68.0	68.0	76.0	72.0	72.0	64.0	60.0	60.0
28	0000001001110011000001001011101 1	71.4	60.7	50.0	46.4	50.0	57.1	57.1	53.6	46.4	50.0
21	1011110000100001011110111011011	71.4	66.7	71.4	61.9	57.1	61.9	52.4	61.9	52.4	47.6
21	0000000000000110011101000100010 0	71.4	42.9	42.9	52.4	52.4	57.1	57.1	47.6	47.6	42.9

21	10000010010000011001001001001010	71.4	61.9	47.6	47.6	42.9	42.9	52.4	57.1	52.4	47.6
28	00001100001000000000101110110010	71.4	57.1	57.1	53.6	53.6	46.4	50.0	46.4	50.0	46.4
21	10000000101000010000010010111011	71.4	61.9	47.6	33.3	38.1	38.1	38.1	33.3	19.1	28.6
21	10110100000100100000101100110100	71.4	57.1	38.1	52.4	38.1	42.9	52.4	47.6	47.6	57.1
21	00000110011011010000101010111011	71.4	76.2	85.7	76.2	76.2	66.7	71.4	71.4	71.4	71.4
52	10110101101000010000101110111011	71.2	51.9	44.2	46.2	51.9	44.2	44.2	42.3	40.4	42.3
24	11001000001000010000000110011011	70.8	50.0	45.8	41.7	41.7	25.0	33.3	41.7	45.8	41.7
24	10000010110000010000101101001010	70.8	50.0	41.7	41.7	45.8	37.5	37.5	37.5	33.3	33.3
24	01001000000101100000001001010000 1	70.8	66.7	41.7	41.7	41.7	37.5	41.7	33.3	37.5	50.0
24	10000100000100100011101100100100	70.8	70.8	58.3	50.0	45.8	41.7	45.8	33.3	37.5	41.7
24	00111001101000010000010010111011	70.8	75.0	66.7	75.0	66.7	62.5	70.8	70.8	70.8	62.5
17	00000000001010011000001000100 1011	70.6	58.8	47.1	76.5	76.5	58.8	64.7	52.9	58.8	47.1
17	11011100011000010000101110111011	70.6	58.8	76.5	76.5	76.5	70.6	70.6	70.6	70.6	76.5
17	10011100001001100000101110110001	70.6	58.8	58.8	58.8	58.8	70.6	64.7	52.9	64.7	64.7
17	10000100000101100111101110110100	70.6	52.9	52.9	47.1	47.1	41.2	29.4	35.3	35.3	41.2
17	00000001100011110000010001001011	70.6	47.1	47.1	35.3	35.3	29.4	23.5	35.3	41.2	35.3
17	00111100001000010010101110111011	70.6	41.2	47.1	29.4	41.2	64.7	41.2	41.2	41.2	41.2
17	00111100000000010000101100111100	70.6	58.8	35.3	35.3	41.2	41.2	29.4	35.3	23.5	35.3
17	10000000001000010001010010111011	70.6	58.8	52.9	58.8	52.9	52.9	58.8	47.1	52.9	58.8
17	10000110110000011011101101001010	70.6	47.1	47.1	47.1	47.1	52.9	58.8	47.1	41.2	47.1
17	01011100001000010111101110111011	70.6	64.7	64.7	58.8	52.9	47.1	58.8	41.2	52.9	41.2
44	00000000001000010111010010011011	70.5	61.4	47.7	52.3	45.5	43.2	40.9	45.5	45.5	45.5
27	00111000000000010000000101001001	70.4	51.9	59.3	59.3	55.6	48.2	40.7	37.0	44.4	37.0

B. TABLES FROM CHAPTER IV

The following table is the results of running the trading systems referred to the stocks have been selected by the fundamental stock screener.

Symbol	% Change Price	% Min Performance	% Max Performance	%Technical Above Price Change	# Avg Success trades of top Indicators	# Avg Unsuccess Trades of top Indicators	% Success Trades of Total - Top Indicators	% Success Trades of Total - Best
AAPL	479.6	193.7	540.2	60.6	13	13	50.0	66.7
ADST	-88.6	-110.7	252.8	341.4	15	14	51.7	50.0
AEE	9.5	-11.2	38.0	28.5	32	18	64.0	64.3
AEP	47.2	0.2	64.4	17.2	30	20	60.0	55.6
ALE	28.7	7.9	53.6	24.9	35	22	61.4	57.4
APY	-86.3	-124.9	77.6	163.9	16	16	50.0	47.7
ASFI	-63.1	-29.2	113.4	176.5	32	25	56.1	55.2
ATCS	-84.8	-149.0	40.9	125.7	18	16	52.9	50.0
AZZ	252.5	152.1	415.0	162.4	28	21	57.1	59.1
BBW	-69.7	-45.5	39.9	109.6	31	28	52.5	53.6
BLD	-20.0	-14.0	151.3	171.3	25	22	53.2	42.9
BLUE	-50.0	42.0	2,652.6	2,702.6	19	46	29.2	39.2
BMNM	-97.5	-52.2	18.8	116.3	12	13	48.0	54.5
BPOP	-52.2	-18.1	23.8	76.0	29	32	47.5	53.3
BUF	-56.9	-131.0	103.0	159.9	21	24	46.7	51.9
CARN	-2.4	-9.7	250.0	252.4	4	3	57.1	100.0
CBAN	-50.3	-70.0	52.9	103.1	22	21	51.2	48.9
CBBO	-32.1	-88.2	90.5	122.6	34	30	53.1	57.4
CFC	-86.0	-43.2	48.9	134.9	26	25	51.0	52.3
CHCG	-89.5	-54.2	127.8	217.3	24	32	42.9	44.7
CIT	-73.0	-38.8	57.2	130.2	34	31	52.3	55.0
CLFC	-47.4	-72.8	35.8	83.2	29	22	56.9	61.5
COGO	116.9	105.1	283.6	166.7	13	12	52.0	83.3
COH	24.1	-5.9	103.3	79.2	34	29	54.0	53.5
COLM	-27.3	-22.9	61.6	89.0	30	21	58.8	60.6
CRD-A	-33.0	-185.4	61.2	94.2	23	22	51.1	58.0
CRD-B	-27.4	-265.4	98.6	126.1	26	23	53.1	51.3
CT	20.0	4.1	96.3	76.3	36	27	57.1	64.2
CTX	-63.2	-50.1	45.5	108.6	34	27	55.7	54.9
CW	77.3	36.8	120.2	42.9	31	25	55.4	52.9
CYGX	-92.2	-150.0	72.1	164.3	9	10	47.4	33.3
CZNC	-19.2	-103.3	52.7	71.9	22	22	50.0	58.1
DCO	43.2	48.0	126.2	83.1	24	18	57.1	100.0
DHI	-46.0	-19.6	64.4	110.4	38	36	51.4	55.0
DHR	37.6	6.8	73.3	35.7	29	21	58.0	60.3
DISH	2.0	-2.0	82.4	80.4	31	27	53.4	56.4
DNA	29.5	35.0	104.2	74.7	32	28	53.3	55.8
DOV	32.5	3.9	82.0	49.5	36	25	59.0	58.8

DPTR	57.6	61.3	192.6	135.1	27	26	50.9	63.2
DR	28.3	-45.7	90.8	62.5	20	12	62.5	64.9
EMC	8.4	21.6	85.8	77.4	23	16	59.0	100.0
EPL	-23.5	16.5	107.6	131.1	21	25	45.7	90.0
FCSE	-58.3	-76.0	87.8	146.1	14	14	50.0	71.4
FE	116.9	27.5	135.3	18.4	22	12	64.7	70.6
FFKY	24.5	-121.6	71.7	47.1	13	15	46.4	46.0
FNM	-57.3	-26.2	57.4	114.7	26	29	47.3	50.5
FRE	-62.0	-44.2	42.2	104.1	28	29	49.1	50.7
GABC	-8.5	-65.5	31.3	39.9	26	21	55.3	56.1
GE	-3.0	-9.6	34.5	37.6	37	31	54.4	55.8
GILD	209.0	25.5	245.8	36.8	21	10	67.7	100.0
GLP	-3.4	8.4	77.5	80.9	21	18	53.8	70.0
GOOG	182.8	102.3	314.9	132.2	11	10	52.4	60.0
GRMN	46.7	45.6	303.5	256.8	33	28	54.1	60.9
GS	84.3	41.7	147.6	63.3	30	21	58.8	57.0
GSX	-23.5	-44.1	92.8	116.3	26	21	55.3	53.8
IACI	-47.0	-33.2	36.9	83.9	31	38	44.9	63.6
INFY	27.2	30.3	106.9	79.6	35	29	54.7	46.2
IRW	50.9	31.2	73.7	22.8	15	20	42.9	45.4
JOSB	10.8	-4.4	136.6	125.8	41	29	58.6	57.4
JST	564.7	320.3	665.0	100.2	21	17	55.3	52.6
JUPM	-90.0	-75.0	74.1	164.1	27	28	49.1	50.0
KBH	-50.6	-50.3	51.1	101.7	24	25	49.0	71.4
LBTYA	46.5	34.8	87.0	40.5	14	16	46.7	55.6
LECO	138.2	27.4	200.8	62.5	23	17	57.5	59.0
LEN	-65.1	-38.3	35.9	101.0	27	27	50.0	54.3
LLL	54.9	3.6	66.7	11.8	28	18	60.9	64.7
MA	527.8	172.2	611.7	83.9	6	4	60.0	70.0
MAXE	-71.4	-72.3	94.9	166.3	10	12	45.5	100.0
MBI	-84.0	-67.8	55.4	139.3	32	26	55.2	55.6
MOG-A	46.1	-109.2	114.4	68.3	35	22	61.4	58.3
MOT	-40.8	-34.0	54.9	95.7	32	24	57.1	60.6
MTH	-69.2	-55.2	50.7	119.9	29	28	50.9	55.7
NHWK	-62.9	-29.7	55.1	118.0	20	18	52.6	80.0
NMR	23.8	14.4	90.4	66.5	36	33	52.2	57.1
NOVL	-3.2	-7.9	74.7	77.9	28	26	51.9	51.3
NVDA	186.6	163.5	403.7	217.0	19	12	61.3	50.0
NYMX	61.9	8.7	152.4	90.5	32	34	48.5	50.7
OMCL	26.2	-40.0	277.1	250.9	34	25	57.6	62.5
PABK	14.3	-11.1	69.1	54.8	27	28	49.1	51.7
PCP	287.4	165.7	335.6	48.3	11	8	57.9	50.0
PERY	72.5	12.1	160.9	88.4	22	17	56.4	50.0
PG	27.0	6.2	39.9	12.9	18	13	58.1	58.7
PHM	-58.0	-24.6	54.8	112.7	32	29	52.5	55.0
PNR	-9.4	-0.7	46.1	55.5	36	29	55.4	45.5
POT	628.2	163.3	746.8	118.6	9	5	64.3	54.5
PRFT	11.9	32.9	191.0	179.0	40	31	56.3	100.0
PRZ	-99.0	-76.7	33.8	132.8	13	19	40.6	47.4

PSA	69.6	44.7	141.0	71.3	22	15	59.5	80.0
PTIE	11.0	-54.1	96.7	85.6	23	26	46.9	62.7
RIMM	402.5	212.0	567.7	165.1	11	8	57.9	63.8
RMBS	-2.1	62.4	197.6	199.6	23	28	45.1	50.0
RMTR	4.3	-16.8	73.3	69.1	23	21	52.3	100.0
SMOD	-28.7	-3.4	81.2	109.9	21	19	52.5	57.1
SO	28.2	-0.9	39.3	11.1	25	17	59.5	57.3
SOAP	1.2	17.0	219.6	218.4	23	29	44.2	47.9
SON	22.6	-4.5	67.7	45.1	27	24	52.9	66.7
SPEC	-2.2	-26.1	129.3	131.5	30	28	51.7	100.0
SSYS	23.8	35.0	115.0	91.2	30	28	51.7	53.2
STEL	-26.9	-120.9	49.4	76.3	30	27	52.6	50.7
STEN	-44.8	-172.8	64.6	109.4	12	15	44.4	40.4
STRC	-25.0	-181.0	103.1	128.1	16	20	44.4	42.8
STST	-41.4	-19.3	42.2	83.6	27	25	51.9	57.9
SXI	-22.8	-130.5	95.9	118.7	36	28	56.3	55.6
SXT	39.0	-39.8	74.8	35.8	24	16	60.0	62.2
SYMC	-23.7	-16.1	45.2	68.9	43	44	49.4	44.0
TKC	60.4	17.9	173.5	113.1	32	26	55.2	56.9
TOPS	2.5	0.0	114.8	112.3	31	45	40.8	34.9
TRAD	40.3	-6.1	151.6	111.3	32	24	57.1	63.5
TRMS	-54.7	-15.6	96.8	151.5	37	28	56.9	55.0
UACL	-2.8	-93.9	125.6	128.4	29	22	56.9	58.9
UBET	-74.5	-70.1	48.5	123.0	21	17	55.3	56.8
UVE	-26.2	-29.7	77.9	104.0	11	11	50.0	50.0
VDSI	63.4	100.1	319.3	255.9	35	35	50.0	52.5
VIP	400.4	183.5	496.5	96.1	14	6	70.0	64.5
WHQ	265.3	114.4	324.9	59.6	15	9	62.5	88.9
WM	-71.1	-52.8	40.5	111.7	29	22	56.9	56.3
XTO	248.1	69.1	246.2	-1.8	9	5	64.3	60.7

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